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ART. XXVI.—*Note on the Sensation of Color;* by C. S. PEIRCE.

IT may, perhaps, be worth while to notice a few consequences of three theories concerning color which are usually regarded with some favor.

First hypothesis.—The appearance of every mixture of lights depends solely on the appearances of the constituents, without distinction of their physical constitution. This I believe is established.

Second hypothesis.—Every sensation of light is compounded of not more than three independent sensations, which do not influence one another. This is Young's theory. It follows that, if we denote the units of the three elementary sensations by i, j, and k, every sensation of light may be represented by an expression of the form,

$$Xi+Yj+Zk.$$

Third hypothesis.—The intensity of a sensation is proportional to the logarithm of the strength of the excitation, the barely perceptible excitation being taken of unit strength. Negative logarithms are to be taken as *zero*. This is Fechner's law. It is known to be approximately and only approximately true, for the sensation of light. From this it follows that, if x, y, z be the relative proportions of a mixture of three lights giving the elementary sensations i, j, k, the sensation produced by the mixture is

$$\mathrm{I}\log x.i+\mathrm{J}\log y.j+\mathrm{K}\log z.k,$$

where I, J, K, are three constants.

From these principles, it follows that if a light giving any sensation such as that just written have its intensity increased in any ratio r, the resulting sensation will be,

$$\mathrm{I}\log rx.i+\mathrm{J}\log ry.j+\mathrm{K}\log rz.k=$$
$$\mathrm{I}\log x.i+\mathrm{J}\log y.j+\mathrm{K}\log z.k+\log r\,(\mathrm{I}i+\mathrm{J}j+\mathrm{K}k).$$

Thus, the result of increasing the brilliancy of any light must be to add to the sensation a variable amount of a constant sensation, $\mathrm{I}i+\mathrm{J}j+\mathrm{K}k$. And all very bright light will tend toward the same color, which may therefore be called the *color of brightness.* Moreover, if the three primary colors be mixed in the proportions which each by itself is just perceptible, the sensation produced will be

$$\log r\,(\mathrm{I}i+\mathrm{J}j+\mathrm{K}k),$$

and can only differ by more or less.

Now I find, in fact, that all colors are yellower when brighter. If two contiguous rectangular spaces, illuminated with the same homogeneous light, uniformly over each, but unequally in the two, they will appear of different colors.

If both are *red* the brighter will appear *scarlet;*
" " *green* " " *yellowish;*
" " *blue* " " *greenish;*
" " *violet* " " *blue.*

If we have the means of varying the wave-length of the light which illuminates the fainter rectangle, we can improve the match between the two, by bringing the fainter toward the yellow. Such motions will converge toward a certain point of the spectrum which they will never cross,—a point a little more refrangible than D and having a wave length of $582{\cdot}10^{-6}$ mm., according to Ångström's map. If both rectangles be illuminated with this light, the fainter appears white or even violet, but if it be varied in wave-length with a view of improving the match, it will be found to return to the same point with the utmost precision.

It appears, therefore, that, if our hypotheses are correct, the color $\log r\,(\mathrm{I}i+\mathrm{J}j+\mathrm{K}k)$ is like that of the spectrum at $\lambda=582$, only that it contains less blue or violet and is consequently of greater chromatic intensity.

It further follows from Fechner's law that, if any light be gradually reduced in brightness, one element of the sensation will disappear after another; and that when very faint it will exhibit only one primary color, which is the one which it contains in greatest proportion relatively to the proportion in the light which has the color of brightness. Now, although this does not seem to be exactly the case, yet we do get some approximation to it. It is true that any light whatever, when sufficiently faint, appears white, owing to the self-luminosity of the retina. We cannot, therefore, unfortunately, get sight of the primary colors by reducing the light of three parts of the spectrum. But we may, as has often been sug-

gested, make use of the principles of contrast. If any red spectral light be sufficiently reduced, it will perfectly match any less refrangible light. We may, therefore, say that a faint spectral red in contrast with a bright light of the same kind, excites with approximate purity one of the elementary sensations. The same thing is true of the violet; and therefore a rich violet may be taken as another primary color. In my book entitled Photometric Researches, the printing of which is nearly complete, I show reason to think that the pure green has a wave length intermediate between E and b. A faint green of this sort contrasted with a bright one appears as a very bluish green, and this may therefore be supposed to be the third primary color.

We have seen that it results from the theory that an increase in the brilliancy of any light adds to the sensation nothing of the peculiar color of that light, but only a certain amount of the color of brightness. If this be the fact, then the photometric sensibility of the eye should be the same for all colors. In order to ascertain whether this is so or not, I have made a series of determinations of my photometric probable error. Each determination was based on twenty-eight comparisons of two parts of the same colored disk. Since there were two unknown quantities, namely, the relative brightness of the two surfaces compared, and an instrumental constant, it follows that only twenty-six observations were effective for determining the probable error. Let R be my photometric probable error of a single comparison. Then the probable error of a single determination of R (which we may denote by r) would be $\frac{\cdot 51}{\sqrt{26}} \times R$, or say $\frac{1}{10}R$. Having made a considerable number of such determinations of R, with different colored disks, let us ascertain their probable error from their discrepancies, considering them as so many independent observations of the same unknown quantity, and denote this probable error by r'. If, then, R really is the same for all colors, we should have

$$r' = r,$$

or, at least, the difference should not exceed ρ, the probable error of r'; which may be calculated by the formula

$$\rho = \frac{\cdot 51}{\sqrt{mr'}},$$

where m is the number of sets of experiments diminished by 1. If, on the other hand, R varies with the different colors, and not merely accidentally, r' should have a larger value. The following are the values I obtained for R, the sum of the brightness of the two surfaces compared being taken as unity.

		R.	Diff. from mean.
Feb. 6.	White	·0041	+·0001
	Red, just before C	·0046	+·0006
	Chrome-yellow, A 2	·0032	−·0008
Feb. 7.	Red, just before C	·0040	±·0000
	Staat's emerald green	·0046	+·0006
	Carmine, B	·0044	+·0004
	Chrome-yellow, A 1	·0037	−·0003
	Purple, Hoffmann's violet RRR	·0033	−·0007
Feb. 13.	Red, just before C	·0048	+·0008
	Green, complementary to carmine	·0034	−·0006
	Blue violet, No. 2	·0048	+·0008
	Yellow, A 1, mixed with black	·0032	−·0008
	Mean	·0040	

After these experiments, the method of observing was changed, and I obtained the following:

Feb. 14.	White window-shade, ill. by sun	·0030	−·0002
	Brown	·0030	−·0002
	Greenish sky-blue	·0037	+·0005
	Very reddish purple	·0028	−·0004
	Yellow orange	·0032	±·0000
Feb. 15.	"Fundamental green of Müller"	·0030	−·0002
	Vermilion, half between C and D	·0034	+·0002
	Violet	·0032	±·0000
	Yellow	·0036	+·0002
	Mean	·0032	

We thus get from the

first twelve determinations, $r=\cdot00040$, $r'=\cdot00048$, $\frac{r'}{r}=1\cdot2$

last nine determinations, $r=\cdot00032$, $r'=\cdot00019$, $\frac{r'}{r}=0\cdot6$

and from the weighted mean, $\frac{r'}{r}=\cdot96$, so that it appears from these experiments that the photometric susceptibility of the eye is the same for all colors. The result is, however, uncertain, because it may be that R is chiefly due to other sources of error than the limitation of sensibility; still, the experiments show as small a value of R as is usually obtained. I shall endeavor, by further observations, to obtain a conclusive result.

A further consequence of our hypotheses will be reached by differentiating the expression for a light-sensation. We have

$$\mathrm{d}(\mathrm{I}\log x.i+\mathrm{J}\log y.j+\mathrm{K}\log z.k)=\frac{1}{x}\mathrm{d}x.\mathrm{I}i+\frac{1}{y}\mathrm{d}y.\mathrm{J}j+\frac{1}{z}dz.\mathrm{K}k.$$

Now, as x, y and z all exceed unity, the differential is greater the

nearer unity x, y and z are. Hence, since the variation of the proportions of the primary colors with a variation of postion in the normal spectrum is uniform,* it follows that the change of color of the normal spectrum should be most rapid about $\lambda=582$, as it of course is. It is also obvious that if the total quantities of the three colors are nearly the same in different parts of the spectrum (I here refer to these colors not as really objective, but as measured in the usual objective way) then the part about $\lambda=582$ must be the brightest, another familiar fact.

I may observe that there is a modification of our formula for a sensation of light, which probably better represents the relations of the sensations. Writing, in the first place,

$$\mathrm{i}=\mathrm{I}i \qquad \mathrm{j}=\mathrm{J}j \qquad \mathrm{k}=\mathrm{K}k$$

the formula is

$$\log x.\mathrm{i}+\log y.\mathrm{j}+\log z.\mathrm{k}.$$

This loses its validity when any of the logarithms become negative. If z is the smallest of the three quantities, we may substitute

$$\mathrm{X}=\frac{x}{z} \qquad \mathrm{Y}=\frac{y}{z}$$

and the formula becomes

$$\log \mathrm{X}.\mathrm{i}+\log \mathrm{Y}.\mathrm{j}+\log z\,(\mathrm{i}+\mathrm{j}+\mathrm{k}).$$

When x or y is smallest there will be two other formulæ. Now, as the variation in the brilliancy of the light affects only the last term of the last formula, and not the first two depending on X and Y, it is more than probable that the eye is habituated to separating the element of sensation which this last term represents, and which is continually changing its values, from the rest which remains constant. It is, therefore, likely that the classification of light into three kinds, according as the *violet*, the *red*, or the *green*, is contained in the smallest proportion, is one which has a relation to the natural powers of discrimination.

My observations have been made with an instrument for which I am indebted to the liberality of the trustees of the Bache Fund. I shall describe it on the occasion of publishing some work of a more serious character. The colored disks made use of were very kindly lent me by Professor Rood.

* I will show this in a note in the next number of this Journal.

ART. XXVII.—*Note on the Binocular phenomena observed by Professor Nipher;* by JOSEPH LECONTE.

THE striking phenomenon described by Prof. Nipher, in the January number of this Journal, was described by Prof. W. B. Rogers, at the Newport meeting of the American Association, 1860, and may be found recorded in the 14th vol. of Proceedings, p. 197. It is only one of innumerable phenomena which are all explicable on the same general principles. The principles involved have been so fully set forth in several of my papers on binocular vision, especially in IV, "On a new method of representing visual phenomena," and VI, "On so-called images of illusion,"* that it is unnecessary to do more than briefly recall them here.

1. The field of view may be regarded as an outward projection of retinal states. As each eye has its own retina crowded with its own *retinal* images, so also each eye must have its own field of view and its own *external* images. There are therefore *two external images* for every object. These may be united, so as to see the object single; or may be separated, so as to produce the phenomenon of double images. *Moreover, the external images of different objects may also be* brought together and superposed at will. In all discussions of binocular phenomena, therefore, it is absolutely necessary that we speak not of objects but *of external images, the signs of objects.*

2. In binocular vision with the optic axes parallel, as in looking at a distant object, the whole visual field with all its external images or objects is shifted by the right eye a half interocular distance to the left, and by the left eye the same distance to the right; so that the two visual lines are brought together in the middle, and combine to form a common median visual line, and the *images of all objects in these lines are brought together and superposed.* This is the necessary result of the law of corresponding points. Retinal images of all objects in the visual lines fall on corresponding points, viz: the central spots; their external images are therefore thrown to the same place in space and are therefore superposed.

Now, in the experiment of Prof. Nipher, the visual line of the right eye passes through the axis of the tube and pierces the center of the circular visible area of the object regarded, while the visual line of the left eye pierces the left hand or paper-sheet or other object placed before it, at a point distant about $2\frac{1}{2}$ inches (an interocular space) from the axis of the tube. Therefore the center of the circular area regarded by the right eye, and the spot on the hand or paper sheet pierced by the

* See this Journal, Jan. 1871, and Dec. 1871.

left visual line, by the law stated above, *are brought together and superposed.*

One thing more to complete the explanation. The impression on the right eye prevails over that of the left—the impression of the circular area *obliterates* that of the corresponding spot on the hand or paper sheet, for two reasons; first, because the circular area is strongly differentiated from the rest of the right eye field of view (the dark interior of the tube) while the corresponding spot on the left-eye field is not thus differentiated; and second, because both eyes are focally adjusted for the distance of the object seen by the right eye only. Thus it comes to pass, that the right eye sees *only the circular area,* the rest of its field being very dark: while the left eye sees *all its field* except the spot covered by the circular area. But if an ink spot be placed on the hand or paper sheet just where the visual line pierces, then the first cause mentioned above will be removed and the strongly differentiated ink spot will be seen in the center of the circular area.

Berkeley, Cal., Feb. 7, 1877.

ART. XXVIII.—*Revision of the genus Belemnocrinus, and description of two new species;* by CHARLES WACHSMUTH and FRANK SPRINGER.

IN 1862, Dr. C. A. White described a type of Crinoids from the Burlington limestone of Iowa under the generic name *Belemnocrinus*, of which he had discovered only a single species. *B. typus.* The description, with a figure, was published in the Proceedings of the Boston Society of Natural History, vol. ix, p. 13. Messrs. Meek and Worthen in the Report of the Geological Survey of Illinois, vol. iii, p. 463, described another species, *B. Whitei* from a specimen having only the calyx preserved. Count Pourtales, in the Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College, No. 8, p. 29, has made some interesting observations upon the relations of *Belemnocrinus* to the recent genus *Rhizocrinus*, and further expressed the opinion that *Belemnocrinus* does not possess, as Dr. White supposed, five small basal plates below the long plates which compose the greater portion of the calyx, but that these long plates are themselves the true basals, thus exhibiting a very marked resemblance to *Rhizocrinus.*

A careful examination of some recently acquired specimens of this genus, including two new species in an excellent state of preservation, and a comparison of these with the original specimens heretofore described, afford us new light in regard to

the structure of this interesting type of fossils, and it enables us to confirm the opinion of Count Pourtales, thereby rendering a revision of the generic formula and description appropriate and necessary.

A specimen of *B. Pourtalesi*, W. & S., has been deprived of the column, and the lower part of the cup is somewhat crushed, in such a manner that two of the long plates are separated along their entire length, exhibiting the sutures to the central perforation which leads into the column. The lower extremities of these plates are excavated, forming a concavity for the insertion of the pentagonal column, the marks of its attachment in a pentagonal outline are plainly visible, thus proving beyond the slightest doubt that these long plates rested directly upon the column, and formed with the first radials, the cup which encloses the visceral cavity. From these facts it follows that the long pieces, which were considered to be subradials, both by the author of the genus and by Messrs. Meek and Worthen in their description of *B. Whitei*, must now be designated as basal plates.

Additional light has been thrown upon the construction of other parts in this genus; every one of the four known species is furnished with a strong proboscis, inflated toward the top, and resting upon the single large anal plate which is a part of the wall of the cup. The exact structure of the summit of the calyx has not as yet been made out, but the comparatively massive character of the plates which compose the proboscis, as well as the size of that organ, render it altogether probable, that it was supported by a solid dome.

The arms, as observed in three of the four known species, are ten in number. They are provided with long, comparatively heavy pinnules, originating on the longer margins of large, wedge-form joints, which alternate with other joints of quadrangular outline, thus giving two rows of pinnules, alternately arranged, to each arm. In both of our new species these pinnules are simple; while those of *B. typus* are furnished with secondary pinnules, which are alternately arranged as the primary pinnules The arms of this genus bear in proportions and general aspect some resemblance to those of *Poteriocrinus*, but they are in fact widely different. In *Poteriocrinus*, the arms divide upon a bifurcating plate or joint, into equal branches, which rest upon the upper faces of this joint; while in *Belemnocrinus* the branches are true pinnules, and not armlets, they spring from the long latteral margin of the syzygial joint, not from its upper side. We have in our possession a specimen which in general aspect somewhat resembles *Belemnocrinus*, the elongated basal plates form here a cylinder apparently solid, almost precisely similar to that of *B. typus*, and as the upper

portion of the calyx is somewhat distorted by pressure, it was at first supposed to be a *Belemnocrinus*. Upon removing the calyx from the surrounding matrix and arranging the plates in their natural position, it was found to possess a series of large sub-radials resting upon the basals, the anal plates arranged as in *Poteriocrinus*, thus exhibiting a fundamental difference from *Belemnocrinus*. Careful examination of the interior part of the cylinder formed by the basal plates, showed that they are thin and enclosed a comparatively large cavity, reaching nearly to the bottom of the cup, thus proving in a highly satisfactory manner the value of the peculiar characters of *Belemnocrinus*.

We are unable to agree with Dr. White in referring this genus to the *Cyathocrinidæ*, as it does not possess the general appearance of that group, nor does it agree in the generic formula as herein given. The slender ovoid or cylindrical base, the long solid basal plates, the shallow cavity in their upper part, and the comparatively small size of the visceral cavity are features which remove *Belemnocrinus* far from *Cyathocrinus*, or any of its allied genera. These characters show its affinities rather with the Jurassic genus *Apiocrinus*, to which in the construction of the calyx and inner cavity, it is more similar and seems to bear a closer relation, than to any other known group.

The resemblance to the recent genus *Rhizocrinus*, pointed out by Count Pourtales, is very close and interesting, even more so than he perceived, since we cannot agree with him that the first radials are movable in *Belemnocrinus*. On the contrary we find them to be closely joined with each other and with the anal plate by exact sutures, the anal plate being in line with them, forming the cup, and supporting upon its upper face the heavy proboscis. The succeeding radials have spaces between the rays, showing them to have been free. The most important difference, and indeed the only essential distinction between these genera in their external structure is found in the solid proboscis and covered dome of *Belemnocrinus*.

As a result of the foregoing observations we give now the following revised

Generic Formula.

Basal plates, five; long, narrow, forming an ovoid to cylindrical cup, which is nearly solid, having a small central perforation, and a shallow subconical excavation at its upper end, which forms a part of the visceral cavity.

Radial plates, four to five × 5; the first series with the anal plate joined at the sutures and composing a part of the cup; the succeeding radials free.

Anal plate, one; supporting a rather long, comparatively large proboscis. Dome covered by solid plates, arrangement

unknown. Arms, ten so far as observed. Pinnules long and strong. Column pentagonal.

As yet found only in the Upper and Lower Burlington limestone.

The following species, new to science, have been discovered by us:

Belemnocrinus florifer, n. sp.

Smaller than *B. typus*. Column comparatively large, composed alternately of large and small joints, the smaller of which are nearly regular pentagons, and the larger pentagonal in outline, arched at the angles, notched in the middle of the sides making the column in general distinctly pentagonal, crenulated transversely, with a somewhat interrupted longitudinal furrow along the middle of each side. To the sixth and eighth large joint from the base, are attached radicular cirrhi which originate in the depressions or notches on each of the five sides of the joint. Traces of other sets of cirrhi are visible lower down on the column. They are all arranged precisely as those of *Pentacrinus Caput-Medusæ*, to the column of which this is in aspect strikingly similar. The cirrhi are long, slender, tapering to the tips, with joints longer than wide, and they increase in size as they approach the root.

The calyx is comparatively low, about two thirds as wide as high, ovoid below, turbinate and rapidly expanding above, constricted about the middle, with a deep transverse suture. The five basal plates are smooth, about three fourths as wide as high, slightly widest near the top, forming the ovoid portion of the calyx, gently expanding from the column outward and upward. They are constricted and abruptly truncated at the summit and appear as a heavy band around the lower part of a second cup which seems to rest in this one. The first radials are large, more than one half the size of the basals, a little higher than wide; outer surface strongly arched, curving rapidly inward at their junction with each other, thus forming deep vertical sutures. They compose, with the anal plate, a cup of conical shape whose sides are crenulated or scalloped by the arching of the plates and the depression of the sutures, and the diameter of which at the bottom is considerably less than that of the ovoid basal cup beneath, in which, rather than upon which, it seems to rest. The radials lie in a line with the sutures of the basals and rest apparently upon the inner edges of the upper faces of these plates. The upper portion of this conical cup in turn projects outward in a rim or band enclosing the arm bases, the arms seeming to proceed from the inside, the calyx and arms thus presenting the peculiar appearance of a bouquet of flowers in a conical vase, which in turn rests in an egg-shaped cup truncated at the base,

thus suggesting the specific name. The upper faces of the first radials are truncated, and upon their inner edges rest the free radials which are four in number, about one-fourth the size of the first radials, a little wider than high and of uniform dimensions up to the arms. The plates of this series are rounded, strongly constricted, transversely in the middle, expanding at their upper faces, producing a rim which envelopes the lower part of each succeeding piece, this rim or wrinkle being rather thicker and more prominent at the lateral margins. The fourth free radial is pentagonal in form, the two upper faces forming an obtuse angle and supporting the arms which are simple throughout their entire length, thus giving two arms to each ray or ten to the species. Arms comparatively very long, rounded, tapering very gradually to the tips, composed of joints which are constricted in the middle, marked by strong lateral wrinkles, thickened at the upper margin to embrace the succeeding joints just as in the free radials. In the lower part of the arms, apparently every third joint, is a syzygium, wedge-form in shape, with quadrangular joints between; while in the upper part the joints are alternately wedge-form, and to the longer margins of these joints the pinnules are attached. These syzygial joints are strong, prominent, and give to the arms an obtusely zigzag appearance. Pinnules simple, rather heavy, very long, directed upward, lying closely along the arms, composed of rectangular joints twice as long as wide, and of nearly equal size throughout their length. Anal plate, rather large, quadrangular in outline, its upper face in a line with the top of the first radials. From the inner part of the upper truncate face of this plate proceeds a proboscis, in height equal to three-fourths the length of the arms. The lower part is composed of large plates nearly equal in size to the free radials, longitudinally arranged, each one resting upon the upper truncate face of the preceding one. Proboscis slightly inflated, the upper part composed of small nodose plates irregularly arranged, while its summit is surmounted by a set of prominent spines whose arrangement cannot be exactly determined.

The entire surface, with the exception of the basal plates, (even the pinnules) is covered by strong wrinkles which produce a peculiar carinated style of ornamentation.

This species is so well marked, and so unlike any other described form, that it may be distinguished with the greatest ease. It differs from *B. typus* and *B. Whitei* in its shorter basal pieces, the extreme size of its first radials, and in the peculiar attachment of the first radials to the basals. In both these species, the suture between the basals and first radials is not prominent, and the latter plates form a continuation of the cylindrical basal portion, while in our species the depth of the

transverse suture, the beveling and constricting of the upper edges of the basals, gives to the basal portion the appearance of enclosing the cup which is formed by the radials. It differs from those species also in the highly arched surface of the first radials and the deep sutures between them, which give to the upper part of the cup its crenulated aspect. Also in the carinated surface. From *B. typus*, it further differs in the mode of attachment of the free radials and arm joints, the rim-like projection at the upper face of each plate, and in the strongly pentagonal and crenulated column.

It differs from our species *B. Pourtalesi*, in most of the above particulars and in the proportionally smaller size of its free radials, in the succession of the syzygial joints, and in the simplicity of the pinnules.

The specimen from which our description is made, is in a most perfect state of preservation, showing column, calyx, proboscis, and arms, the calyx being plump and every plate exactly in position.

Geological position and locality: from a thin cherty layer near the middle of the Upper Burlington limestone, Burlington, Iowa. Collection of Charles Wachsmuth.

Belemnocrinus Pourtalesi, n. sp.

Smaller than either of the other described species. The column is unknown, but, from the impression of its attachment to the lower excavated parts of the basal plates, it was evidently more or less pentagonal.

Calyx low, about two thirds as wide as high, basal cup subglobose, constricted and truncated above and deeply excavated below for the reception of the column. The portion composed of the first radials and anal plate, being a little less in diameter at its junction with the basals, expands upward and gives to the whole calyx a form somewhat urn-shaped.

Basal plates nearly uniform in size, two-thirds as wide as high, slightly widest above, strongly convex and bulging in the middle, being curved somewhat like the staves of a cask, upper faces nearly truncate, lower faces truncated with abruptly rounded edges and excavated. They are heavy plates, solid below, leaving only a small perforation connecting with the column.

Radials, four. The first radials, alternately arranged with the basals, are only one-third of their size, wider than long, quadrangular, closely joined at the lateral sutures, and slightly set in from the outer upper edge of the basals, leaving a rather deep transverse suture. Second and third radials as wide as the first and more than twice as wide as high. Fourth radials larger than the others, pentagonal, supporting upon their upper sloping faces the free arms.

Arms comparatively robust, tapering rather rapidly to the tips. The arm joints are at their surface angularly elevated in the middle, depressed toward the sides, the sutures between them have at the middle angular part of each joint a strong downward curvature, a peculiarity which is also observable in the radial series. The arms in this feature recall the characteristic structure of those of *Taxocrinus* and *Forbesiocrinus*. Throughout the greater portion of the arms, every alternate joint is a syzigium, very obtusely pentagonal, twice as large as the other arm joints, and to the longer margin of each which is slightly angular, is attached a pinnule. The pinnules originate on a very distinct articulating scar near the upper part of the plate. The intermediate plates are quadrangular in outline. From the bifuricating radial to the second pinnule two quadrangular joints are interposed between those to which the pinnules are attached. The great size of the syzygial joints, as compared with the others, and their rather pentagonal shape, cause the pinnules to branch from the arms at a considerable angle, and also give to the arms a marked waving form. The pinnules spring alternately from every second syzygial joint on either side of the arms, they are simple, composed of quadrangular joints, heavy, long, tapering but slightly, nearly all thus maintaining the same size throughout their entire length.

The ventral sides of the arms and pinnules are in our specimen perfectly covered with alternating minute plates. The same arrangement of plates has been observed by us arching the ventral furrow in the arms of *Cyathocrinus*, *Poteriocrinus*, *Synbathocrinus*, and *Cupressocrinus*, and Messrs. Meek and Worthen have observed it in the arms of *Batocrinus*. We are led to believe that the ventral furrow was similarly arched in all Paleozoic Crinoids.

The anal side and proboscis are hidden in our specimen and cannot be described. The surface of the radials and arms is indistinctly carinated.

B. Pourtalesi can be readily distinguished from any other known species. From *B. florifer*, which it perhaps most nearly resembles, it differs in its more globose basal cup, its smaller first radials and its wider free radials, which are fully twice as wide in that species, also in the proportionally shorter and heavier brachial pieces, the extreme size of the syzygial joints as compared with the intermediate ones, the robust and rapidly tapering arms, in the angular form of the arm joints, the curving sutures between them, and in the peculiar shape and crenulated upper part of the calyx of that species. From *B. Whitei* it differs in its shorter, more globose and smaller cup and in the form of the first radials. From *B. typus* in the same respects, and also in the waving form and angular surface of the arms.

We take pleasure in dedicating this elegant species to Count L. F. de Pourtales, the eminent Zoologist of the Museum of Comparative Zoology at Cambridge, Massachusetts, who first called attention to the relations of this genus to one of the types of recent Crinoids.

Geological position and locality: from the lower part of the Lower Burlington Limestone, Burlington, Iowa. Collection of Frank Springer.

ART. XXIX.—*On Thorpe's and Bunsen's methods for the Estimation of Nitrogen in Nitrates;* by S. W. JOHNSON.—*Contributions from the Sheffield Laboratory of Yale College.* No. XLVI.

IN volume xxvi, pp. 541, 549, of the Journal of the Chemical Society, as well as in his treatise on Quantitative Analysis, p. 95, Thorpe has described a method of estimating nitric acid, in which this acid is reduced to ammonia by the use of slips of zinc coated with precipitated copper, a reducing combination first employed by Gladstone and Tribe. The experimental results given by Thorpe in support of his method are such as apparently establish its great exactness, while in simplicity and ease of execution, it would seem to be quite superior to the similar methods that have been previously proposed.

Having occasion to make some determinations of nitric acid, I tested Thorpe's method in five distinct trials with pure sodium and potassium nitrates. The directions given by Thorpe in his Quantitative Chemical Analysis are as follows:

About 25–30 grams of thin sheet zinc are placed in a flask of about 200 c. c. capacity, and covered with a moderately concentrated and slightly warmed solution of copper sulphate. In about ten minutes a thick spongy coating of copper will be deposited on the zinc; the liquid is poured off the metals, which are now well washed with cold water and covered with about 40–50 c. c. of pure water. Weigh out about 0·5 gram of pure nitre into the flask connected with a condensing arrangement. The liquid is gradually heated and distilled for about an hour. The distillate is treated with platinum tetrachloride.

These directions were followed as closely as possible save that the distillate was received in a standard acid in order to measure the ammonia volumetrically.

In the first experiment 0·5712 of sodium nitrate were employed, containing 0·09408 of nitrogen. After distillation was concluded, the distillate contained 0·02947 of nitrogen. Thinking that the zinc hydroxide resulting from reduction of the nitrate might retain ammonia beyond the power of simple dis-

tillation to remove, although Thorpe makes no such suggestion, I added a quantity of newly fused, pure caustic potash, and more water and distilled again.

This second distillation gave additional ammonia equal to 0·0227 of nitrogen.

The total nitrogen thus obtained was:

1st	distillation,	0·02947
2d	"	0·02275
		0·05222 instead of 0·09408

Or a deficiency of 45 per cent.

In a second trial, 0·6689 grams of sodium nitrate were taken. The conditions of reduction were as near as practicable the same as before, but on completing the first distillation the odor of nitric oxide was plainly evident in the receiving vessel, and the amount of free acid in the latter was greater than at the outset, the standard acid, not only being not neutralized by ammonia coming from reduction, but made more acid by the reaction of nitric oxide upon the oxygen and water of the condensing vessels.

In a third experiment with 0·4193 grams of pure potassium nitrate, 40 grams of cleansed zinc were covered with concentrated copper sulphate solution for fifteen minutes, the precipitated copper was washed with great care to avoid as much as possible detaching it from the zinc. 40 c. c. of water and the nitrate were added, the mixture heated very gradually and distilled finally with addition of more water, for one hour. The result was like that of experiment 2.

A fourth trial resulted in the same increase of acid in the receiver. In all these cases the copper was very loosely attached to the zinc, so that by mere washing much of it, and on boiling most of it separated.

I now referred to Gladstone's description of his method of preparing the zinc-copper couple, and made a fifth experiment, following his different directions as follows:

A weak solution of copper sulphate (1·5 per cent $CuSO_4$) was employed, and the zinc was let remain in it for some time until the color of the solution was very nearly discharged. The distillation was then conducted as Thorpe directs.

0·5338 grm. KNO_3 containing	13·84	per cent	N.
yielded	5·20	"	N.
deficiency=	8·64	"	N.

Thorpe mentions no difficulty in the application of his process except in case of ammonium nitrate. With reference to its analysis he says, "the discordances appear to depend upon differences in the strength of the solution and the amounts of

zinc and copper taken. If the solution is too strong, nitrogen dioxide is evolved, and if the amount of zinc and copper be insufficient, the reduction is incomplete." It is evident that the process needs further study to define the conditions of its successful employment.

In contrast with the above results I instance three estimations of nitrogen made by Bunsen's method,* on the same sample of potassium nitrate and with aid of the same standard alkalimetrical solutions as were employed in the experiments just described. In Bunsen's method the reduction is effected in the cold, in presence of 250 or 300 c. c. of water and excess of caustic potash by zinc-iron couples, prepared by twisting together sheets of the two metals.

The time of reduction in the first trial was twelve, in the others thirty, hours. After these times, the ammonia was distilled into the standard acid. The results were as follows:

	1.	2.	3.	Theory.
Nitrate taken,	0·4593	0·3374	0·2651	
Nitrogen found,	13·29 p. c.	13·49 p. c.	13·25 p. c.	13·84

The results fall short, it is seen, from 0·35 to 0·60 per cent.

My acknowledgments are due to Mr. E. H. Jenkins, for assistance in these trials.

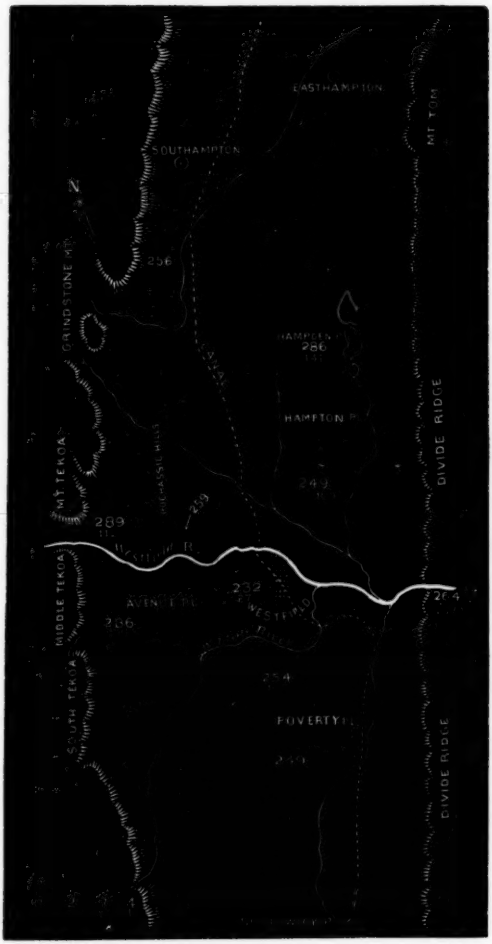
ART. XXX.—*Westfield during the Champlain Period;* by J. S. DILLER, of Westfield, Massachusetts.

WESTFIELD, Massachusetts, is nine miles west of Springfield, and six miles north of the Connecticut State line, in a valley cut off from the western part of the Connecticut valley by the Divide Range (the trap ridge extending south from Mount Tom). The village of Westfield is situated between Westfield River and Westfield Little River. These rivers flow eastward, across the valley, and, after uniting a mile east of the village, their waters pass through the Divide Range into the Connecticut River below Springfield.

The region contains three extensive plains. Hampton Plain, beginning near Hampden Ponds, four miles northeast of the village, extends south to the Westfield River. Avenue Plain extends, from the mountains west of Westfield, east between the two rivers to the village. Poverty Plain begins south of the rivers, and extends south by the Southwick Ponds into the Farmington valley. Stratified deposits in the northern part of the Hampton Plain, near Hampden Ponds, are 286 feet above mean sea-level. From this place the plain slopes south

* Fresenius's Zeitschrift, x, p. 414.

twelve feet per mile to near the Catholic cemetery, and is there 249 feet above mean sea-level, or 104 feet above highest modern flood-level at Westfield. A plain extending south from near Easthampton toward the Hampden Ponds, slopes in the same



direction. The divide between Northampton and Westfield is crossed, west of Hampden Ponds, by a valley through which the old canal extends. The highest plain in this valley near Southampton is 256 feet above mean sea-level, and slopes

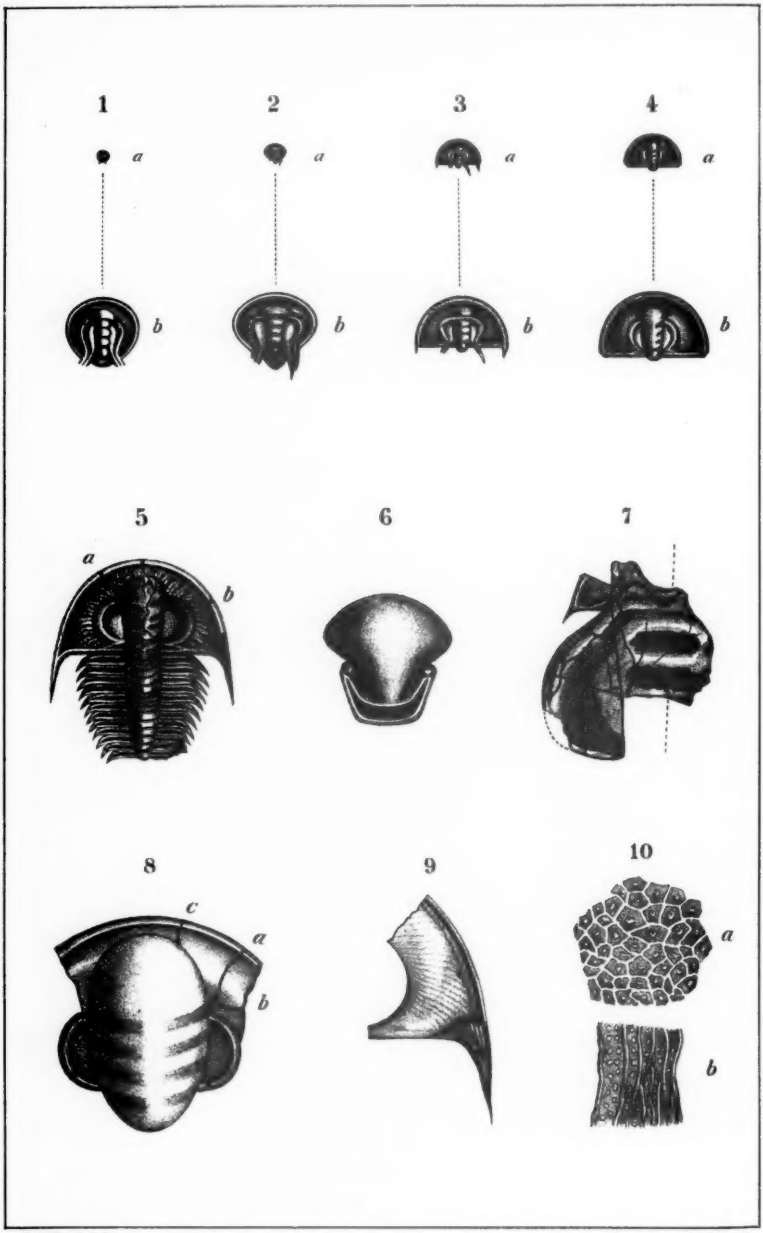
toward the south. The northern part of the Hampton Plain is made of very coarse material, which gradually becomes finer toward the south. In the gravel of this plain, pebbles of trap are found.

Poverty Plain is highest just south of Westfield Little River, where the stratified deposits are 254 feet above sea-level (109 above flood-level at Westfield), and slopes toward the south three and a third feet per mile. The material of the Poverty Plain is finer than that of the Hampton Plain. Poverty Plain is separated from Hampton Plain by the valley of the two rivers, and extends south into Farmington valley. The slope of these plains toward the south, and the grade in the material of the Hampton Plain in the same direction, are unmistakable evidences that during the period of their deposition, the Champlain period, the water must have flowed over these plains from north to south.*

The appearance of trap pebbles in the Hampton Plain points to the same conclusion. Not any trap rock is found in the basin of the Westfield River west of the Divide Range. Hampton Plain is separated all along its eastern boundary from the Divide Range (trap) by a ridge of sandstone rising far above the stratified drift of the plain. From these conditions it is evident that the trap could not have been washed into the plain from either the east or west. Following the Divide Range to Mt. Tom, it will be seen that this mountain owes its height to the westward advance of the trap and underlying shale, making it to rest directly upon the hard conglomerate which forms a separate ridge south of Mt. Tom. The talus of trap on the western side of Mt. Tom would be carried, by a stream flowing south, along the western base of the mountain, directly into the Hampton Plain. There seems to be no doubt that the pebbles of trap are from Mt. Tom, and were carried into their present position by a stream from the Connecticut River flowing south (as Professor Dana has already shown), west of Mt. Tom, over the Hampton and Poverty Plains into the Farmington valley.

The highest stratified deposits in the vicinity of Westfield are near Mt. Tekoa, 289 feet above the sea, and 112 feet above the flood-level of the Westfield River where it issues from the mountains. Hampton Plain, as already stated, rises 286 feet above the sea. According to Professor Dana, there is a terrace at Tariffville, Conn., fourteen miles south of Westfield, in the same valley, having a height 275 feet above sea-level. He has taken this as proof that the height of the flood over the middle part of the Westfield basin was at least 275 feet. The heights

* Professor J. D. Dana derived the same conclusion, this Journal, vol. x, Dec. No., 1875, pages 504–507.



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given above, one in the valley and the other, a greater height, upon its side, show, after making reasonable allowance for the slope of the water, that the level of the highest flood was at least 280 feet above mean sea-level.

During the greatest flood, the Westfield River and the Westfield Little River, joining the waters from the Connecticut, flowed south over the Poverty Plain into the Farmington valley. The lower deposits in this vicinity were made by the Westfield Rivers before the overflow from the Connecticut began. One of the first results of the overflow from the north must have been to fill the former valley of the Westfield Rivers, so that during the time of greatest flood the Hampton and Poverty Plains must have been one continuous plain.

The north end of the Poverty Plain is five feet higher than the south end of the Hampton Plain, and while the latter slopes twelve feet per mile the former slopes only three and a third feet per mile. The material of the Poverty Plain is finer than that of the Hampton Plain. The differences in height, slope, and material, are all due to the confluence of the three streams upon the Poverty Plain, and to the damming of the water by the Southwick Divide.

The Avenue Plain, at its western extremity, reaches its greatest height, 286 feet above mean sea-level and 109 feet above flood-level of the Westfield River, at Mt. Tekoa. From this place it slopes east sixteen feet per mile to the village cemetery, where its height is 232 feet and 87 feet above flood-level of the Westfield River at Westfield. The east end of the Avenue Plain is at least seventeen feet lower than the adjacent ends of the Hampton and Poverty Plains, showing that seventeen feet of stratified deposits must have been swept off the east end of Avenue Plain.

When the flood subsided, the overflow from the north ceased, and the Westfield rivers began to flow once more through the Divide Range into the Connecticut. By their conjoined action they eroded the Avenue Plain to its present level, and cut for themselves, across the once continuous plain, deep valleys, with the terraced sides that now appear.

ART. XXX.—*On some Embryonic Forms of Trilobites from the Primordial Rocks at Troy, N. Y.;* by S. W. FORD. With Plate IV.

THE existence, in the case of a number of species of Bohemian Trilobites, of a series of forms showing that, before reaching maturity, the animal passed through several widely distinct phases of growth, is a fact long ago made familiar to geologists

by the researches of M. Barrande. In one instance, that of *Sao hirsuta*, he has shown that twenty such phases are passed through, the earliest and simplest forms being of almost microscopic minuteness and presenting scarcely any resemblance to the individual when completely developed. These phenomena have been styled by Barrande the "Metamorphoses of Trilobites;" and in his truly magnificent work on the Trilobites of Bohemia (Systême Silurien de la Bohême, vol. i, 1852,) they are fully and ably set forth and discussed. Hitherto, however, no example of a truly embryonic form of trilobite, or one showing that the animal was mainly developed after quitting the egg, has been found in other than Bohemian strata; a fact which, when we consider the prodigious numbers of these animals that existed in Paleozoic times, the care with which the rocks in which they occur have been explored in many countries, and the profound study which their remains have received at the hands of many distinguished investigators, would seem to indicate that, in the greater number of species, no such forms ever existed. I beg leave to submit herewith the evidence I have obtained of the metamorphoses of an American trilobite, the species being the *Olenellus* (*Elliptocephalus*) *asaphoides* of Emmons. I shall discuss this evidence, together with certain other material which I possess pertaining to this species, under the following heads:

Genus OLENELLUS Hall.

OLENELLUS (ELLIPTOCEPHALUS) ASAPHOIDES Emm.

I. *Embryonic Forms.*

In the spring of 1868 I discovered several specimens of this species in the limestone beds at Troy, showing clearly the characters of *Olenellus*, which were afterward fully identified with the Washington County form by Mr. Billings. Since that time I have added to my list of specimens whenever opportunity has offered. Although some of the specimens obtained early in the course of my investigations appeared to me somewhat rudimentary in character, yet it is only of late, and after laboriously working away the partially enveloping rock, that I have become fully aware of the real richness of the material. Further researches will doubtless supply much that is still desirable.

Fig. 1*a* represents, natural size, the earliest stage of growth observed, and 1*b* the same enlarged five diameters. The specimen is nearly circular, one line in greatest width and length, with a wide concave border which, toward the edge, is bent upward so as to form a neat marginal rim. The glabella is three-fifths the total length. It is divided into five distinct lobes by four well defined furrows extending all across. The

forward lobe is considerably larger and spreads out laterally beyond the others, which are of nearly equal shape and dimensions. It stands out prominently in the specimen. The eye-lobes are of an elongate semi-lunate form, and, springing from the postero-lateral angles of the forward lobes of the glabella, extend backward nearly as far as the last glabellar furrow. At the posterior extremity of each and in direct continuity with them is a well-defined rounded ridge which extends outward and backward toward the postero-lateral margin, with the raised edge of which it unites to form a slender spine. The spaces between the eye-lobes and glabella are tumid and are prolonged backward as two spines lying within the former. These I shall, for convenience, call the "inter-ocular" spines. I have no doubt but that all of these spines terminate in acute points, as they are all seen to taper slightly in the specimen; but as they pass beneath the stone a short distance from the disk, I have thought it better not to run the risk of destroying them altogether in attempting to further develop them. Between the two spines last described lie the last glabellar lobe and its appendage, the latter a simple, smooth, narrow, nearly flat or only feebly convex plate, convex in outline behind, and giving to the specimen its nearly circular form. This plate I consider to be a rudimentary pygidium. I believe this to be one of the most rudimentary trilobitic forms ever discovered. At present it appears to me to be equally humble in structure with the form representing the first stage of growth of *Sao hirsuta* illustrated by Barrande. The head is greatly predominant. There is no thorax, and no pygidium properly so called.

With regard to the nature of the spines and ridges which I have just described I became greatly puzzled as my study of the specimen continued. At first I was disposed to look upon them as simply ornamental in their nature, regarding the ridge which runs backward from the eye-lobe as simply the eye-lobe itself fancifully prolonged. Afterward, however, I was led to take the *economy* of the animal organization into account, and from the moment of doing this I was conducted to very different conclusions from those first entertained. I believe the outer spine of this individual to represent the permanent spine of the genal angle in the adult, and the little ridge which runs backward from the eye-lobe to this spine and helps to form it to represent that portion of the posterior margin of adults which lies between the genal angle and the facial suture. The inter-ocular spines I am inclined to regard at present as having been most probably protective in their office. Between the ridges extending from the eye-lobes and these spines there is an open space or *slit* in the shield. This space represents, I believe, the position of the posterior portion of the

facial suture in the adult. At this stage that portion of the posterior margin of adults which lies within the sutures is not even indicated. The specimen presenting these remarkable features of structure is in a beautiful state of preservation.

Fig. 2*a* represents another specimen, natural size, and 2*b* the same enlarged three and one half diameters. The lower left hand portion of the border is slightly restored in each. This specimen is, in extreme width, two-thirds larger than the first example, and in extreme length, exclusive of the spines, one-half larger. The form has changed considerably, but it requires but a moment's attention to convince one that the fundamental structure is, in all respects, the same with that of the preceding example. The shield is more spread out laterally, and markedly so at the mid-length; the eye-lobes in their forward portions are more arched; the glabella is more acutely and regularly tapering; and the proportional distance between the inter-ocular spines at their origin is considerably increased. The glabella is marked by four distinct furrows extending all across as before. Immediately in advance of the fourth or foremost furrow there is a slight ridge extending all across the anterior lobe, which gives to the eye-lobes the appearance of meeting on the median line of the glabella. The neck-furrow is strongly marked. On either side of the neck-segment is a short, deep, longitudinal furrow with an elevated rim bounding it behind. We have here rudely sketched out that portion of the posterior margin of adults which lies inside of the sutures. In contact with this margin there is a somewhat convex, triangular body, the central portion of which is damaged, but which shows on each side two or three obscure furrows extending outward and backward. This body, both from what Barrande has taught respecting the mode of development of the thorax of trilobites and from the appearances themselves, I consider to be most probably a rudimentary thorax and pygidium combined. From the even manner in which it is outlined it is probable that none of the segments were yet free. The surface of both this and the foregoing specimen is smooth.

Now, if we examine the figures it will appear evident, I think, that, between 1 and 2, one or more intermediate forms may exist, and between 2 and 3 a considerable number of such forms. As yet, however, no such forms have been obtained. Figure 3*a* shows, natural size, and 3*b* twice enlarged, a head whose development is evidently nearly completed, but which is, nevertheless, embryonic in certain of its features. There still exist the strong inter-ocular spines and the glabellar ridge uniting the eye-lobes in front. The glabellar furrows also extend all across, but become fainter on the median line. The eye-lobes are rather more regularly curved than represented in the figure.

In this specimen we have the first indication of the fine system of surface lines which ornaments so beautifully, in many instances, the adults. From the posterior extremity of the eye-lobe there is a slender though distinct ridge running backward parallel with the inter-ocular spine, lying close alongside, to the marginal edge and forming with it a continuous elevation. Between this little ridge and its adjacent spine is the place of the suture. In this, as in the preceding example, the inner formed portions of the posterior margin wall against the inter-ocular spines. These spines are here clearly seen to lie *in* the marginal border, or rather between its still disunited outer and inner portions, appearing as if occupying a little notch in that border especially intended for their reception. The spines of the posterior angles are only partially preserved.

In figure 4*a*, which is of the natural size, and *b* the same enlarged as before, the posterior margin is continuous or united at the sutures; but there is a little ridge running from the base of the eye-lobe to the marginal edge, as in the preceding case. This character is likewise shown in all perfect adult specimens. The specimen is perfect excepting the posterior spines. The characters are all only those of adult growth. There are three pairs of glabellar furrows in advance of the neck-furrow, none of which reach the median line, and in addition, as is likewise true of most adult specimens, a short, fainter fourth pair in front of the anterior extremities of the eye-lobes. The neck-furrow is continuous all across. The spaces between the eye-lobes and glabella are but moderately convex and were no longer provided with spinous appendages. The surface of the cheeks is ornamented with exceedingly fine waved lines, best shown in the concavity just within the marginal rim.

I have purposely dealt with figure 4, under this head, in order to prepare the way for a better understanding of certain features of structure presented by the embryonic forms to which I wish more particularly to refer. Returning to figure 3*a*:—on comparing this form with 2*a*, we observe the principal differences to consist in the relatively greater lateral expansion of the postero-lateral portions of the shield in the former, these being extended so as to give to the form a nearly semicircular outline; the relatively smaller size of the tumid spaces between the eye-lobes and glabella; the relatively nearer approach of the posterior portions of the eye-lobes to the glabella; and in the presence of a nearly perfectly formed, though not, as yet, united posterior border. With the completion of the perfect union of the posterior margin at the sutures, the inter-ocular spines appear to have been no longer of use and were altogether suppressed. Figure 4 is an example of this. But in all essential features of structure I believe 2 and 3 to be fundamentally

the same. If, in the case of figure 2 we were to suppose that portion of the ridge running from the lower extremity of the eye-lobe which does not enter into the composition of the spine of the general angle to be elastic, and then draw the lower end of the eye-lobe downward and inward as close to the glabella as possible, at the same time carrying the genal angle outward a little way, we should get a short horizontal posterior margin between the outer and inner spines. This is similar to what, I believe, has, in effect, actually occurred in the growth and development of this form, the growth being both inward or toward the line of suture and outward or toward the angle, giving us a form such as we observe in figure 3. I have no doubt but that future discoveries will bring to light forms illustrating this, and also showing us more fully the various stages of unfolding passed through in the development of this extraordinary species of trilobite.

II. *Adult Forms.*

Fig. 5 represents, twice enlarged, an unusually perfect specimen. It is of a young individual, but the characters show that it was, without doubt, a fully developed form. The head is somewhat crushed and fractured, but the main features are beautifully shown. The thorax is incomplete, and the pygidium is wanting. There are twelve pairs of ribs preserved. These decrease in length in a regular manner, constituting an exceptional feature in the structure of the genus.* In one of the three specimens of this species figured in Dr. Emmons' works there are fourteen articulations in the thorax, but it is impossible to say whether this is the total number possessed by the individual. His figure also shows one of the posterior spines of the head in place with its characteristic surface-markings.† In our specimen the whole surface of the head beyond the eye-lobes and glabella is covered with irregularly alternating finer and coarser lines radiating outward to the margin. These lines are somewhat too coarsely represented in the figure, but it shows well the peculiar character of the ornamentation. In this specimen the slender ridges running from the eye-lobes to the posterior margin along the sutural lines are very apparent. The eye-lobes are not actually in contact with the glabella behind as shown in the figure, which would also slightly change the direction of the ridges extending from them. At *a* and *b* the shield is fractured, but I do not consider either fracture as

* See Barrande,—"Documents anciens et nouveaux sur la faune primordiale et le Systême Taconique en Amerique." Bul. Geol. Soc. France, 2 Ser., vol. xviii, p. 203, 1861. Also, the writer, "Note on *Microdiscus speciosus*," this Journ., Feb., 1877, p. 141.

† "American Geology," pl. 1, fig. 18, 1855. See also "Taconic System," pamph., 4to, p. 21, 1844.

coincident with the course of the suture. In fig. 8, which represents the glabella, eye-lobes, and portions of the cheeks of a large individual, the whole considerably weathered, there are three such fractures. Of these *a* coincides very nearly in relative position and direction with *a* in fig. 5. But this coincidence appears to me to be only accidental. It is possible, judging from a specimen in my collection showing the under side of the head with the hypostoma in place, that the line *c* coincides with the suture, but I do not feel at all satisfied of this. I have never been able to ascertain to my entire satisfaction the direction of the suture in front of the eye in any specimen. The shield appears to have fractured as easily in one direction as another. This would seem to indicate that the cheeks were very firmly united at the sutures in front. This, if true, has an important bearing upon what I have stated in regard to the mode of formation of the posterior border in the embryonic stages; for if, according to my view, the posterior portions of the sutures were, almost from first to last in the progress of the metamorphoses, only *indicated* by the structure, the spaces in the developing margin which they were to occupy being long left open, we can readily understand why the anterior portions of the shield should have been firmly held together. The changes that took place in the forward portion of the shield during the period of development were, as compared with those in the backward, relatively unimportant both as to kind and amount.

This species sometimes attained an enormous size. One specimen of the glabella in my collection is an inch in width at its narrowest part. The surface of the head in some cases presents an exceedingly ornate appearance. Occasionally the whole surface of the cheeks is covered with small polygonal areas having a little prominence in the center of each, these areas being formed by the irregular interlacing of the fine raised surface lines. In other cases this arrangement holds good for the more central portions of the cheeks, while toward the margin the lines become more regular in direction and better defined, and sometimes become so widely separated as to enclose two or more rows of what were before the little tubercles or prominences in the polygonal spaces. Figs. 10*a–b* are intended to illustrate what is here meant, *b* being a small segment of the outer portion of a cheek greatly enlarged, and *a* an enlargement of one of the inner portions. At other times the whole surface of the cheeks is covered with tubercles with no enclosing lines, and at still others with only irregular lines with no tubercles.

Fig. 9 is of a portion of one of the cheeks preserving its spine. The upper crust is nearly all removed, but at the spine we see it present with its usual ornamentation. The specimen

is, for the most part, a cast in stone of the outer or lower surface of the "doublure," which is shown to be ornamented in much the same way as the upper surface of the shield. Along the outer edge there is a portion of the doublure itself remaining.

III. *The Hypostoma and Epistoma.*

Of the hypostoma of this species I have several specimens, one of which, a very perfect example, is here figured twice the natural size (fig. 6). Its form and structure both show it to be very closely related to the hypostoma of *Paradoxides*. The surface is smooth. The central body is exceedingly convex. In his description of the type of the genus, *O. Thompsoni* (13th Regents' Rep. and elsewhere), Professor Hall says of the hypostoma that it is "broadly ovate, little longer than wide." As this description was too imperfect to be made available in comparison, and was unaccompanied by a figure, we were thus left in doubt regarding the testimony of this, one of the most important parts of trilobites that can be employed in the identification or differentiation of genera. In the form of the hypostoma, the shape of the glabella, and in its *facies*, this genus is evidently closely related to *Paradoxides*, more closely I believe than to *Olenus*, as was originally believed by most paleontologists who investigated it. The glabella in all the species is widest at the frontal lobe. In the case of *O. asaphoides* we see that this is a feature that is early marked out in the structure.

In a small number of species of trilobites described and figured by Barrande, there is shown to exist a second plate quite similar in shape to the hypostoma, but placed in the interior of the cephalic shield. This he has called the "epistoma." We have not hitherto found this organ in any American trilobite. About three years ago I obtained an enormous glabella of *O. asaphoides*, beneath which there appeared to be at one point indications of the existence of a plate of different character from anything I had previously seen. The specimen remained in my hands in this state for a long time, but I finally succeeded in developing the body referred to, which is the remarkable form represented (nat. size) in fig. 7 of the plate. It shows a central or sub-central elevated area with two deep oblong parallel furrows; an elevated left-hand border, and between these a wide concavity. At the upper left-hand portion is the cast of a stout spine. Just to the right of this a portion of the plate has been removed. The surface presents a smooth polished appearance. This plate I believe to be the epistoma of this species.

The specimen whence this plate was obtained consisted as originally discovered of two parts, one showing the inner surface of the crust of the glabella, and the other its impression in

limestone. Beneath this latter, at about a line's depth, was shown a portion of the plate in question. At present the specimen consists of three parts, or rather four: (1) The inner surface of the glabella; (2) a limestone cast of the same; (3) the epistoma attached to the lower side of No. 2; (4) a cast of the lower or mouthward side of the epistoma, and preserving its spine. The layer holding the epistoma came away in several pieces. These have been glued together, and the relations of the parts of all four of the pieces can be made out with ease and certainty.

As will be seen from the figure, the plate is in a fragmentary condition. Compared with the hypostoma it is probably represented in an inverted position in the drawing. The upper portion in the figure is probably the backward portion in the specimen. This is, moreover, its position beneath the glabella. It lies diagonally across the latter, with its spinous portion resting directly beneath the neck-segment. It has doubtless become detached and slipped backward. It appears to me probable that the straight dotted line in the figure indicates approximately the middle line of the perfect specimen. This is all that I desire to say upon the subject at present.

To sum up: I believe the facts which have been presented prove conclusively that we have in *Olenellus asaphoides* an example of the metamorphoses of trilobites, and clear up some points that have always been in doubt concerning the genus, besides affording us a more complete life-history than we have hitherto possessed of any trilobite from American strata. In my investigation of this singular life-history I have striven earnestly to read the record aright. How far I have succeeded in this must remain for my fellow laborers in the department to determine.

All of the specimens described and figured in this paper were collected by the writer from the limestone beds of the Lower Potsdam Group at Troy, N. Y.

New York, February, 1877.

ART. XXXI.—*The Winds of the Globe; or the Laws of Atmospheric Circulation over the surface of the Earth;* by JAMES H. COFFIN, LL.D., Professor of Mathematics and Astronomy in Lafayette College.*

THIS volume, to which the author devoted many years of earnest labor, may be considered, as its title implies, an exten-

* *The Winds of the Globe; or the Laws of Atmospheric Circulation over the surface of the Earth;* by JAMES H. COFFIN, LL.D., Professor of Mathematics and Astronomy in Lafayette College. xxvi and 756 pp. 4to, with 26 plates. Washington, 1876. Completed, on the author's decease, by Professor Selden J. Coffin, Ph.D.; with a discussion and Analysis by Dr. Alexander Woeikof.—Smithsonian Contributions to Knowledge.

sion of his earlier treatise on the Winds of the Northern Hemisphere. Its design is to show

1st. The mean direction of the wind in all parts of the earth.

2d. The ratio that the progressive motion bears to the total distance traveled.

3d. The modifications that the mean current undergoes in the different seasons of the year.

4th. The directions in which the forces act that produce these modifications.

5th. The amount of their intensities.

6th. To show, by separate solutions for the surface winds and those indicated by the motion of the clouds, how the two differ, and how they differ according as we do, or do not, take into account the difference in the velocity of the different winds.

The data used for elucidating these points consist of series of observations on winds made at 3,223 different stations on land, and during numerous voyages at sea, extending from the parallel of 83° 16′ north latitude, to beyond the parallel of 75° south latitude, the extreme points ever reached by man, altogether embracing an aggregate period of over 18,500 years. If the area between latitude 60° N. and 60° S., where observations are more abundant, be divided into geographical squares, by drawing meridians and parallels of latitude 5° apart, of the 1728 squares so formed 1410 are represented in this work. The 318 vacant squares, from which no observations have been obtained, are as follows: Twenty-one in North America, mostly in British America; forty in the interior of South America; none in Europe; seventy in Central Asia; sixty-three in Africa; fifteen in the interior of Australia; one hundred and eight in the North Pacific Ocean; and one in the South Pacific Ocean.

It seems eminently desirable that the great paucity in the North Pacific Ocean, should be filled; particularly as it is supposed that the material for doing so exists, though entirely unreduced, among the archives of the United States Naval Department.

To facilitate condensation in the results, the stations that reported directly to the Smithsonian Institution have been grouped into convenient districts, about 100 miles square, and the total number of observations has been given for at least eight points of the compass, during each of the four seasons. In the case of most other stations, and particularly when the series extended through a long period of years, the total number of observations is given for each month of the year, and to sixteen points of the compass. By this summary the distinctive features of the system of winds in any part of the earth are not obliterated by condensation, excepting, of course, when those of a particular epoch are sought, as in the case of

the investigation of storms. For this the present work is not available; although the author appreciated this end, as shown in his preparation of a previous work,* in which 300 pages are devoted to selected records from 400 localities in the United States, extending through several days each, in the case of storms that occurred in March and September, 1859, and noting not only the winds, but all the accompanying meteorological phenomena.

The method of summing and presenting this mass of material, is by five series: in each of which the separate seasons and points of the compass are kept distinct, viz:

I. The number of observations.

II. The number of miles traveled, as estimated by the observers.

III. The mean velocity in miles per hour.

IV. The number of observations taken on the upper current, as indicated by the motion of the clouds.

V. A velocity table computed from the first three series, the results of which will be noted farther on.

In series I, II and IV, the trigonometrical resultants are computed, both as to direction and the ratio of the resultant to the sum of the winds. Of these the work embraces 16,000 solutions, about one-half of which find place on the charts. The deflecting forces have been wrought out in about 8,000 of these instances.

The peculiarity of series V may be seen in an example. Certain stations in New Hampshire, north of latitude 40°, during the years 1854 to 1857 inclusive, give the following result:

	Spring.	Summer.	Autumn.	Winter.	Year.
Average velocity of all winds in miles, per hour,..	8·16	6·39	6·48	8·91	7·48
Velocity in mean direction, on the supposition that the winds from every point of the compass move with the foregoing velocity,.....	2·72	1·67	2·77	3·82	2·66
True velocity in mean direction, giving to the winds from every point of the compass each their own average velocity, as shown in the table above,..	2·91	1·80	2·70	4·48	2·88
Excess of the latter over the former.....	+·19	+·13	−·07	+·66	+·22

Let the movement of a particle of air be traced, which is supposed to be stirred only by the winds that are found day after day at a given place: at the end of the year the path of the particle, though entirely irregular, will—so far as its progress and general direction are concerned—be essentially the same

* Results of Meteorological Observations, 1854–59. Vol. II, Part 1.—United States Senate Document, 36th Congress.

as the curve more easily formed by joining the four lines, whose direction and length are recorded in the resultants of series I. On the North American coast of the Atlantic the curve is of this general shape ⌣⌒, while on the European coast the curvature is reversed, being ⌒⌣. The change seems to occur in mid-ocean at longitude 30° to 35° west. Except where there are marked local obstructions to the free flow of the air, this law seems invariable; and it holds in the majority of cases, even in the motion of the clouds; but Mount Washington, New Hampshire, seems a remarkable exception; the observations for 1870–3 give as resultants—

	Resultants.	Ratio.	Monsoon influence.	
Spring,	N. 87° 21′ W.	·62	S. 17° 15′ W.	·13½
Summer,	N. 62° 33′ W.	·62	N. 12° 30′ E.	·13
Autumn,	N. 60° 46′ W.	·63½	N. 9° 3′ E.	·15½
Winter,	N. 87° 38′ W.	·60	S. 9° 1′ W.	·13½

These S-shaped curves were pointed out and illustrated by Professor Coffin, in 1848, at the same time that he announced the existence of the Polar system of the northeast winds, and the Temperate system of the westerly winds. The forces that deflect the wind from its mean annual direction, and so cause these peculiar curves are given under the title of Monsoon Influences. Are they due to changes in the temperature, or to variations in atmospheric pressure at the different seasons? An examination of the maps shows instantly that in all parts of the globe, these deflecting forces are inclined toward the nearest adjacent land-center in the summer, and toward the center of the nearest large body of water in the winter, thus showing the direct agency of heat in modifying the direction of the current, and the intensity of its flow. That barometric pressure however plays the more important part in effecting these seasonal changes of direction is shown in Dr. Woeikof's minute discussion; wherein, reproducing the isobaric charts of Dr. Alexander Buchan, he considers the five wind systems in general, and then treats separately the winds in the smaller geographical divisions of the earth. He corrects the error, so generally prevalent, of limiting the monsoons to the tropical part of Asia, showing that they extend as well to all China, Japan, Mantchooria, the western coast of the Sea of Ochotsk, and the basin of the Amoor river; and, with a reverse of seasons, to Australia.

The winds on the whole Atlantic coast of the United States were early shown by Professor Coffin to possess some monsoon features, though slight. The influence of the Gulf of Mexico over the basin of the Mississippi and Ohio, from latitude 34° to 42°, in producing the west-southwest direction of the winds at all seasons, is traced to the constant maximum pressure existing to the south and the minimum to the north and northeast.

Dr. Woeikof instances latitude 40° to 60° south as that part of the earth where the winds have the greatest velocity, strong westerly winds prevailing there the whole year: due to the great difference in the pressure of the air at a small distance, or in other words, the steep barometric gradient. As to this topic, Professor Coffin left on record but a few general conclusions, of which we would note only his determination of 65° as the average angle made by the line of the wind's approach, with one drawn to the point of maximum pressure.

The velocity tables, elaborately prepared, mainly from data in the United States, are designed to show the effect of combining the element of velocity with that of time, in computing the resultants. The question is one of vital importance, and the magnitude of the task alone hinders its being solved in a similar manner for all parts of the world. Five years of working time were spent on the reduction of the observations taken at 418 places on the American continent, for a total period of 700 years. The results show that the effect of velocity is to throw the resultant northerly far more frequently than southerly, and at a much greater angle; that it increases its magnitude far more frequently than it diminishes it, and by a greater amount.

In the United States, north of latitude 32°, the annual results obtained by noting the actual velocities average S. 89°+W., with a ratio of ·261; while those had by disregarding the unequal velocities are S. 80°+W., ratio ·227. The divergence is therefore about 9° in the yearly resultants, but greater in winter, and less in summer.

This general fact of a [northerly] divergence and excess of ratio, holds true also for the few places computed, that are situated within the limits of the Polar and Equatorial systems; yet, as the divergence seldom exceeds 15°, the great general conclusions reached must be considered safe, although the variation in velocity be disregarded.

The average velocity, so obtained, of all winds in the United States, is seven miles an hour, being slightly in excess in the northeastern part of the Union, and less in the States nearer the center of the continent.

For positions considered separately, the velocity of the wind is greater—

1. On high isolated peaks, than at low stations,
2. On the seashore, and especially on isolated islands, than in the interior of continents,
3. In level countries, than in countries surrounded by mountains; and
4. In prairies, and especially desert countries, than in wooded regions.

A less velocity than the average belongs to the winds of the equatorial calm-belt, the calm-belts at the polar limits of the trade-winds, and the trade-wind belts.

There is an extensive region in the southwest of the United States, which has a common yearly period of winds, different as are its geographical features. It includes the extreme southeast of California, Arizona, New Mexico, Southern Utah, Texas, Arkansas, the Indian Territory, Eastern Colorado, Eastern Wyoming, Southern Dakota, Nebraska, Iowa, Kansas, and Missouri. The winds are southeast, south, or southwest in summer, with a great ratio of the resultant in the south, diminishing toward the north and east. In winter the winds are mostly north and northwest. This region is equal to more than a million square miles, or about one-third of the United States, without Alaska.

A comparison of the motions of clouds with the mean direction of the surface current, shows that they very nearly coincide in nearly all regions of the United States; the former being more purely west, and having a ratio of resultant of 42 per cent—nearly double that of the surface current, which is 23 per cent—thus showing a steadiness of motion admitting of little monsoon influence; while the lower current has a more west-southwest direction between the Mississippi and the Appalachian chain, and a west-northwest direction in New England.

As the northern and southern boundaries of the great westerly current are approached—at least in the United States—the length of the arrows that designate the cloud current decreases as much below the 42 per cent above named, as they surpass that figure in the center of the aerial stream; and thus the southern limit of this system of cloud motion seems to extend down to north latitude 30°, some three degrees farther south than is assigned to the corresponding system of surface winds.

The work is rich in tabular matter, especially from Spain, Norway, Russia, Siberia and India. Twenty-six charts are attached, in which the general features of the wind systems are delineated, mainly by resultants and wind-roses; the latter bringing into contrast the summer and winter winds. Horary, monthly and annual variation is traced; and one chart exhibits the connection of the wind with fluctuations in the thermometer, amount of cloudiness, and fall of rain and snow. The whole forms a valuable summary of facts in this department of meteorology.

ART. XXXII.—*On some Nitro-derivatives of Diphenylamine;* by Dr. PETER TOWNSEND AUSTEN.

A PRELIMINARY notice of the following investigation was published in the Berichte der Deut. Chem. Ges., vol. vii, p. 1248. I had hoped, long before this, to have completed the research in a more satisfactory manner, but my time having been occupied with other subjects, I have but recently been able to return to it.

Pisani* found that trinitrochlorbenzol acted on ammonia, and formed trinitroaniline. Clemm† applied this reaction to aniline, and obtained a trinitrodiphenylamine. In a similar manner he produced a dinitrodiphenylamine by the action of dinitrobrombenzol on aniline.

The reaction in all of these cases is simple—

$$C^6H^2(NO^2)^3Cl‡+2NH^3=C^6H^2(NO^2)^3NH^2+NH^4Cl$$

Several nitro-derivatives of diphenylamine had already been discovered by Hofmann§ before the research of Clemm was made. They had, however, not been produced by the introduction of a nitrophenyl-complex into aniline, but by the direct nitrition of benzoyldiphenylamine, and subsequent elimination of the benzoyl-group.

The trinitrochlorbenzol was made by Clemm's method: 100 grams of picric acid were well mixed with 200 grams of phosphorous pentachloride, and placed in a large retort connected with an inclined condenser. On heating gently, the mass began to fuse, on which the burner was taken away. The reaction proceeds by itself and is very violent. After the ces-

* Ann. Chem. Pharm., xcii, 326. † Jour. Pr. Chem. [II], i, 145.

‡ On the ease of substitution of haloid atoms in nitro-compounds, see my Einleitung zu den aromatischen Nitroverbindungen, page 8. "Chlorbenzol lässt beim Behandeln mit alkoholischem Ammoniak unter keinen Umständen sein Chloratom durch die Amidogruppe substituiren. Chlormononitrobenzol aber bei erhöhter Temperatur; Chlordinitrobenzol bei 100°; während Chlortrinitrobenzol schon in der Kälte energisch auf Ammoniak wirkt. Aus diesen, wie aus zahlreichen andern ähnlichen Thatsachen, ziehen wir die Schlussfolgerung, dass die Nitrogruppe die Anziehung der andern negativen Atome lockert. (Vergleiche auch Salkowski (Ber. Chem. Ges., vi, 141), Engelhardt und Latschinoff (Zeit. Chem., 1870, 225), Walker und Zincke (Ber. Chem. Ges., v, 114).)"

"Umgekehrt dürfen wir voraussetzen, dass dieselbe die Anziehung der positiven Gruppen des Moleküls verstärken müsse. Dass diese Voraussetzung richtig ist, geht aus dem Verhalten der Amidogruppe hervor. Behandelt man Anilin mit Amylnitrit, so ist die Einwirkung sehr heftig, bei Nitroanilin weniger, bei Dinitroanilin sehr ruhig, während Trinitroanilin keine Reaction giebt." According to Körner (Jahresbericht, 1875, 365), however, the weakening action of the nitro-group on halogens is only exerted when the relation is 1·2 or 1·4, not extending, however, to 1·3.

§ Ann. Chem. Pharm., cxxxii, 160.

sation of the action, most of the phosphorous oxychloride was distilled off. The heavy red liquid, remaining in the retort, was poured into a large excess of cold water and violently stirred. After the phosphorous oxychloride had been entirely decomposed by the water, and the mass had solidified, the impure substance was well washed with water, powdered, and extracted with ether by means of a filter pump. A dark-red resin was by this means removed. The bright yellow powder, left on the filter, was dissolved in boiling absolute alcohol and purified by animal charcoal.

In this manner beautiful bright yellow crystals of trinitrochlorbenzol were obtained. By drying they became darker. The yield is from 30–40 per cent.

I obtained better results, however, by simply heating the substances in a high beaker glass, for I found that a considerable amount of the chlorpicryl was destroyed during the distillation of the phosphorous oxychloride. I found, also, that the yield was far better, when instead of 100 grams of picric acid and 200 grams of phosphorous pentachloride, 50 grams of picric acid and 100 grams of phosphorous pentachloride were taken. By this method the conversion of the picric acid into chlorpicryl, the decomposition of the phosphorous oxychloride, the extraction with ether, and the crystallization from alcohol, all together do not take more than an hour.

The trinitrochlorbenzol fused at 82·5°–83°. By dissolving it in glacial acetic acid, diluting the solution with water, and allowing it to stand, superb feathers, frequently over two inches in length, were obtained.

*Alphatrinitrophenylmetanitraniline.**

Preparation.—25 grams of metanitraniline (112°) and 27 grams of chlorpicryl were dissolved in boiling absolute alcohol. On boiling the solution for a few minutes, the separation of a heavy yellow crystalline sand began. This sand was not redissolved by addition of more alcohol. The solution was allowed to cool, the precipitate separated by filtration, purified by crystallization from glacial acetic acid, dried at 100°, and analyzed.

Analysis.—A combustion† gave—

0·2744 grms. of substance burned with lead chromate gave 0·414 grms. of CO^2 and 0·582 grms. of H^2O.

0·2752 grms. of substance gave V=48·8 c.c. [B=764·8 mm.; t=21·5°].

* The trinitrophenyl-complex of picric acid is in this research distinguished by the prefix *alpha*. The relation is most probably para, but it requires experimental demonstration. (Compare Gnehm. Inaug. Diss.)

† The large number of nitro-groups present in these compounds rendered the use of an unusual amount of copper spirals necessary.

The formula $N\begin{cases} C^6H^4(NO^2)_m \\ C^6H^2(NO^2)^3{}_a \\ H \end{cases} = C^{12}H^7N^5O^8$

Calc.	Found. I.	II.
C=41·20	41·15	----
H= 2·00	2·36	----
N=20·05	----	20·33

The mother liquor contained the nitraniline chlorhydrate. The nitraniline was precipitated by sodium hydrate and, after purification, used again.

The reaction is exactly analogous to the one representing the formation of trinitroaniline (loc. cit.).

$$C^6H^2(NO^2)^3Cl + 2C^6H^4(NO^2)NH^2 = N\begin{cases} C^6H^4(NO^2) \\ C^6H^2(NO^2)^3 \\ H \end{cases} + C^6H^4(NO^2)NH^2{\cdot}HCl$$

Solubility.—Almost entirely insoluble in hot water, coloring it yellow, however: hardly soluble in boiling ether, carbon disulphide, carbon tetrachloride, chloroform, and absolute alcohol. Insoluble in chlorhydric, nitric (dil.) and sulphuric (dil.) acids. Easily soluble in concentrated sulphuric acid to a deep red wine color, and is separated unchanged in the form of yellow flocks on the addition of water. In aniline it is easily soluble with a beautiful red color. In hot amyl-alcohol it is easily soluble, but crystallizes badly therefrom. In hot glacial acetic acid it is easily soluble, and separates in the form of a beautiful orange-red crystalline sand. From a solution in acetylchloride it crystallizes in small wine-yellow transparent crystals.

Aqueous ammonia dissolves it very easily, the solution attaining a splendid scarlet-red color. By evaporation it separates unchanged. In weak aqueous solutions of alkalies it behaves as with ammonia. Concentrated solutions of sodium and potassium hydrates, especially by heating, decompose it with evolution of ammonia.

Properties.—The compound consists of a heavy, crystalline, yellow sand, fusing at 205° to a red liquid which, when undisturbed, solidifies at about 175°. By careful heating it volatilizes in the form of a yellow powder. It burns with a yellow luminous flame when heated on a platinum foil, and leaves a porous coal. If it be thrown on a hot surface it explodes like gunpowder. By percussion it is not explosive.

Alphatrinitrophenylparanitraniline.

Preparation.—This compound was made in a manner similar to the preceding one. Paranitraniline (made by nitrition of acetanilide, elimination of the acetyl-group by boiling with concentrated chlorhydric acid, and decomposition of the nitraniline chlorhydrate by sodium hydrate) with the calculated amount

of picryl chloride was brought into solution in boiling absolute alcohol. On continuing the boiling, a red crystalline powder separated.

Analysis.—The substance was purified by crystallization from glacial acetic acid, dried at 100°, and analyzed.

0·2888 grms. of substance burned with lead chromate gave 0·4354 grms. of CO^2 and 0·5920 grms. of H^2O.

0·2852 grms. of substance gave V=49·8 c.c. [B=767mm.; t=23°].

The formula $N\begin{cases} C^6H^4(NO^2)_p \\ C^6H^2(NO^2)^3{}_a \\ H \end{cases}$ = $C^{12}H^7N^5O^8$

Calc.	Found.	
	I.	II.
C=41·26	41·12	----
H= 2·00	2·27	----
N=20·05	----	20·07

Solubility.—The solubility of this compound is nearly the same as the preceding one, being, in general, somewhat higher. In aqueous ammonia it is easily soluble to a red color. Acids precipitate it unchanged from this solution. From alcoholic ammonia it crystallizes in beautiful glittering leaves.

It dissolves in a warm solution of sodium carbonate to a scarlet-red color. On cooling, violet needles separate. This, without doubt, is the sodium salt of the alphapicrylparanitraniline, $N\begin{cases} C^6H^4(NO^2)_p \\ C^6H^2(NO^2)^3{}_a \\ Na \end{cases}$. The needles are soluble in alcohol and water, and are decomposed by acids.

It is insoluble in an aqueous solution of ammonium carbonate. Easily soluble in amyl alcohol, crystallizing therefrom in bright, glittering, yellow scales. In aniline it dissolves easily, and separates on evaporation in a crystalline form. It is also quite soluble in benzoyl chloride, acetyl chloride, benzyl chloride and chlorbenzol.

Properties.—In general this compound seems to possess more acid properties than its isomer. The pure substance fuses at 216°.

Dinitrophenylmetanitraniline.

Preparation.—Calculated amounts of dinitrobrombenzol (produced by nitrition of brombenzol) and metanitraniline were rubbed to a pap with absolute alcohol, and the mixture heated twenty hours at 100° in a closed tube. The reaction took place in the most satisfactory manner.

On cooling, the tube contained hard brown crystals. They were washed on a filter with warm alcohol until the filtrate contained no trace of nitraniline chlorhydrate.

Analysis.—The substance was purified by repeated crystallization from an excess of glacial acetic acid, dried at 100°, and analyzed.

0·2780 grms. of substance burnt with lead chromate gave 0·0896 grms. of H^2O and 0·4844 grms. of CO^2.

0·2822 grms. of substance gave V=46 c.c. [B=757·2 mm.; t=22·2°].

The formula $N\begin{cases} C^6H^4(NO^2)_m \\ C^6H^3(NO^2)^2{}_p \\ H \end{cases} = C^{12}H^8N^4O^6$

Calc.	Found. I.	II.
C=47·36	47·81	----
H= 2·63	3·57	----
N=18·42	----	18·66

Solubility.—The substance is insoluble in water, alcohol and ether. Difficultly soluble in boiling glacial acetic acid. It is soluble in an excess of boiling chloroform, separating in small yellow crystals.

Properties.—Small glittering yellow crystals, fusing at 189°* to a red liquid. With alkalies it behaves in the same manner as the trinitrophenylparanitraniline.

Dinitrophenylparanitraniline.

Preparation.—The calculated amounts of dinitrobrombenzol and paranitraniline were treated as in the production of the preceding compound. On cooling the tube contained a mass of dark-red crystals. They were washed with dilute alcohol.

Analysis.—As the substance did not crystallize from any solvent, it was purified by solution in glacial acetic acid and precipitation by water. In this manner, bright yellow flocks were obtained. After three repetitions of the solution, precipitation, and washing, the substance was dried at 100° and analyzed.

0·3080 grms. of substance burnt with lead chromate gave 0·5386 grms. of CO^2 and 0·0912 grms. of H^2O.

0·2348 grms. of substance gave V=37·6° [B=755·3 mm.; t=19°].

The formula $N\begin{cases} C^6H^4(NO^2)_p \\ C^6H^3(NO^2)^2{}_p \\ H \end{cases} = C^{12}H^8N^4O^6$

Calc.	Found. I.	II.
C=47·36	47·68	----
H= 2·63	3·29	----
N=18·42	----	18·29

* Wilgerodt announced (in Ber. Chem. Ges., ix, 1178) a dinitrophenylmetanitraniline which he had produced by the action of *a* $C^6H^3(NO^2)^2Cl$ on metanitraniline. This is perhaps identical with my compound, although he finds a fusing point of 194–5°.

Solubility.—The substance is *easily soluble in cold glacial acetic acid.* It here shows a striking difference from the dinitrophenylmetanitraniline which is *difficultly soluble in boiling glacial acetic acid.* It is difficultly soluble in cold absolute alcohol, easily in hot.

Properties.—The compound forms a light-yellow and extraordinarily light, elastic and electric powder. It fuses at 181°. Owing to the small amount of the substance at my disposal, I have not been able to investigate its properties more thoroughly.

Since the picrylnitranilines contain the mononitrophenyl-group, it appeared extremely probable to me that a further nitrition could be effected. In this case, since the trinitrophenyl-group seems to be the limit of direct nitrition of the phenyl-group, I could predict* that by the nitrition of the picrylnitranilines, higher nitro-members would be formed, and that the nitro-groups would enter into the mononitrophenyl-group. If, then, by the nitrition of the picrylnitranilines, higher isomeric nitro-compounds were obtained, the isomerism must reside in the nitrized mononitrophenyl-group, since the trinitrophenyl-group remains unchanged during the nitrition.†

It is, however, very possible that in *one* of the resulting compounds the two picryl-groups may be identical.

Since the positions of the nitro-groups in these dipicrylamines has not been ascertained, I shall represent the trinitrophenyl-group of picric acid by α, and the dinitromononitrophenyl-groups of meta and paranitraniline by β and γ respectively. Only two of these picryl-groups can be identical.

* Supposing that the imido-group would withstand the action of the nitrous acid.

† That is, we suppose it does. The supposition will doubtless remain synonymous with the fact for some time to come. Picric acid remains unchanged by the action of nitrizing agents. Hence we suppose that this trinitrophenyl-group when combined in the picrylnitraniline also remains unaltered during nitrition. I have no proof, however, that the introduction of two nitro-groups into the mononitrophenyl-group does not exert a displacing action on the members of the picryl-group.

In nitrizing the paradibrombenzol, I find that the relative amounts of isomers formed are not constant. This seems to depend on the strength and the amounts of the acids used as well as on the duration and temperature of the heating. I am, at present, endeavoring to determine this more exactly, in the hope of being able to produce more of a given isomer at will.

An interesting field is opening in regard to whether several isomers are formed at once, or whether one is formed first and the others from it by atomic migration. If the latter is the case, then the production of relative amounts of isomers is partly under control. In this connection it is interesting to remark that Doer (Ber. Chem. Ges., v, 795. Compare Hlasiwetz, Wien. Acad. Ber., xxiv, 237) by nitrition of diphenylmethane obtained a dinitro-compound, while by continued digestion of the nitrition mixture he got an isodinitro-compound. 1·4 nitrophenol is formed in the cold, the 1·2 compound, however, by heating (Jahresbericht, 1875, 364).

Alphapicrylbetapicrylamine.

Preparation.—The alphapicryl-metanitraniline was added in small portions to a cooled mixture of equal volumes of fuming nitric and concentrated sulphuric acids. The liquid became hot, and a violent reaction set in. After the reaction had subsided, the liquid was poured into cold water. A bright sulphur-yellow cream was in this manner obtained. If, however, the acid solution is boiled for half an hour, the substance is completely destroyed, and, on pouring the liquid into water, only a resin is obtained.

After washing out the acid with water, the cream was well extracted with alcohol, by which means a resin, giving a deep orange-red solution, was removed. The substance was then dissolved in boiling glacial acetic acid, and precipitated by concentrated chlorhydric acid, well washed with dilute chlorhydric acid, dissolved again in boiling glacial acetic acid, boiled some time with animal charcoal, filtered, and allowed to crystallize.

Analysis.—A portion of the substance was purified by crystallization from glacial acetic acid, dried at 100°, and submitted to analysis.

0·2876 grms. of substance gave 0·3490 grms. of CO^2 and 0·0404 grms. of H^2O.

0·2924 grms. of substance gave 0·3538 grms. of CO^2 and 0·0404 grms. of H^2O.

The formula $N\begin{cases} C^6H^2(NO^2)^3\beta \\ C^6H^2(NO^2)^3a \\ H \end{cases} = C^{12}H^5N^7O^{12}$

Calc.	Found.	
	I.	II.
C=32·8	33·09	32·99
H= 1·13	1·56	1·53

Solubility.—It is almost insoluble in hot water, coloring it, however, slightly yellow. Chlorhydric, nitric and sulphuric acids do not increase its solubility in water. In hot amyl and ethyl alcohols it is almost insoluble, hardly soluble in ether, carbon tetrachloride, carbon disulphide, and chloroform. In cold glacial acetic acid, difficultly soluble, in the hot acid, it dissolves easily. In aniline, it is easily soluble.

In aqueous ammonia, sodium and potassium hydrates, it dissolves easily with a superb scarlet color.

Properties.—Impalpable bright sulphur-yellow powder. By careful crystallization from glacial acetic acid, it can be obtained in small transparent glittering crystals. It fuses at 261° to a red liquid, which at 175°–170° solidifies to a red glass. By touching it with a hard object when in a liquid state, it solidifies to a yellow amorphous mass.

Vapors of ammonia turn it scarlet. By boiling with moderately concentrated solutions of sodium and potassium hydrates, it decomposes with evolution of ammonia. In an aqueous solution of sodium carbonate it dissolves easily, forming the sodium salt.

By addition of water to the boiling glacial acetic acid solution, a thick precipitate is formed, which, after crystallization from glacial acetic acid, showed a fusing point of 205°, and on analysis proved to be the original picrylmetanitraniline from which this dipicrylamine had been prepared. *By the addition, then, of water, to the boiling solution in glacial acetic acid, the alphabetadipicrylamine loses two nitro-groups and is converted back into the picrylmetanitraniline.*

The dipicrylamine does not explode by percussion. If heated, it puffs with a white luminous flame, and leaves a light porous coal. It explodes with violence when thrown on a hot platinum foil.

Alphapicrylgammapicrylamine.

Preparation.— This compound was prepared by nitrition of the picrylparanitraniline in the same manner as in the case of the preceding compound. On pouring the resulting mixture into cold water, the substance separated as a light greenish-yellow cream. After extraction with alcohol it was crystallized from glacial acetic acid, dried at 100°, and analyzed.

Analysis.—

0·2836 grms. of substance burnt with lead chromate gave 0·3480 grms. of CO^2 and 0·0436 grms. of H^2O.

0·2792 grms. of substance gave V=54·3c.c.[B=756^{mm}; t=22°].

The formula $N\begin{cases} C^6H^2(NO^2)^3\gamma \\ C^6H^2(NO^2)^3\alpha \\ H \end{cases} = C^{12}H^5N^7O^{12}$

Calc.	Found.	
	I.	II.
C=32·80	32·08	----
H= 1·13	1·70	----
N=22·32	----	21·91

Solubility.—The solubility is about the same as that of the preceding compound.

Properties.—Small transparent glittering light-yellow prisms with a green reflex. It fuses at 230° with effervescence and decomposition. It puffs on being heated, and explodes with violence when thrown on a hot surface. With alkalies, it behaves like the alphabeta-compound.

I have already mentioned that these compounds, particularly the dipicrylamines, give fine scarlet colors with alkalies.

According to Hofmann, the mono- and dinitrophenylamines give similar ones. This fact was substantiated by Clemm.

I find that these colors are caused by the formation of salts of the nitrodiphenylamines. The hydrogen atom of the imido-group has become so negative by the introduction of the nitro-groups, that it can easily be substituted by basic atoms. It reacts easily, indeed, with carbonates of the alkalies.

Of the numerous salts of these compounds which I have prepared, I have as yet had time only to investigate one—the barium salt of the alphabetadipicrylamine.

Barium-alphapicrylbetapicryldiamine.

Preparation.—The $\alpha\,\beta$-picrylamine was added to an aqueous pap of barium hydrate (or carbonate). The dipicrylamine dissolved immediately with a deep intense red color. The solution was boiled for a few minutes and then evaporated on a water-bath. After a sufficient concentration had been obtained, the solution was allowed to stand. A beautiful crystallization of dark-red needles was obtained. They were purified by repeated crystallization from water.

Analysis.—A portion of the needles were dried at 100° and mixed with sodium carbonate and nitrate. Some sodium carbonate was then fused in a platinum crucible, and the mixture added to it in small portions. The resulting solution was kept in fusion about five minutes, and then allowed to cool. After it had become quite cold it was dissolved in very dilute chlorhydric acid, filtered, the solution brought to boiling, and precipitated with sulphuric acid.

0·4012 grms. of substance gave 0·0908 grms. of $BaSO^4$.

The formula $Ba\left\{\begin{matrix} N\left\{\begin{matrix} C^6H^2(NO^2)^3\beta \\ C^6H^2(NO^2)^3\alpha \end{matrix}\right. \\ N\left\{\begin{matrix} C^6H^2(NO^2)^3\beta \\ C^6H^2(NO^2)^3\alpha \end{matrix}\right. \end{matrix}\right. = C^{24}H^8N^{14}O^{24}Ba$

Calc.	Found.
Ba=13·52	13·30

The reaction by which this barium salt is formed is very simple:

$$2(NH[C^6H^2(NO^2)^3]^2)+Ba(OH)^2=Ba[N(C^6H^2(NO^2)^3)^2]^2+H^2O$$

Solubility.—Quite easily soluble in boiling water, less so in alcohol.

Properties.—Small, dark saffron-red glittering needles. It seems to have enough basic properties to form salts with weak acids. This interesting fact I hope shortly to prove. If it be brought into a flame, it explodes in a remarkable manner, flying through the air with brilliant coruscations, and giving a beautiful barium-flame. Thrown on a hot surface it explodes with great violence.

With the hydrates and carbonates of the metals, the dipicrylamine yields in the same manner fine salts.

The most beautiful salt which I have yet obtained is the ammonium-alphagammapicrylamine. It crystallizes in superb intense red transparent rhombohedrons (?). Whether it is identical or only isomeric with the dyestuff "Aurantia," which is now produced on a large scale, I have not had an opportunity of ascertaining.

By treatment of the sodium salts of the dipicrylamines with picrylchloride, a reaction takes place doubtless with the formation of the tertiary picrylamine, $N(C^6H^2(NO^2)^3)^3$.

Immediately after the publication of my preliminary notice, Gnehm* announced some new nitrodiphenylamines which he had obtained by nitrition of methyldiphenylamine, the methyl-group having been eliminated during the operation.†

The following table will show the various nitrodiphenylamines known, their method of preparation, and properties.

No.	Rational Formula.	Empirical Formula.	Remarks.
I.	$N\begin{cases}C^6H^5\\C^6H^4(NO^2)\\CO.C^6H^5\end{cases}$	$C^{19}H^{14}N^2O^3$	Hofmann, HNO^3 on $N\begin{cases}(C^6H^5)^2\\CO.C^6H^5\end{cases}$ Light-yellow crystals.
II.	$N\begin{cases}C^6H^5\\C^6H^4(NO^2)\\H\end{cases}$	$C^{12}H^{10}N^2O^2$	Do., NaOH on No. I.
III.	$N\begin{cases}C^6H^4(NO^2)\\C^6H^4(NO^2)\\CO.C^6H^5\end{cases}$	$C^{19}H^{13}N^3O^5$	Do., fuming HNO^3 on $N\begin{cases}(C^6H^5)^2\\CO.C^6H^5\end{cases}$ Deep yellow crystalline substance.
IV.	$N\begin{cases}C^6H^4(NO^2)\\C^6H^4(NO^2)\\H\end{cases}$	$C^{12}H^9N^3O^4$	Do., NaOH on No. III. Red. yellow needles with metallic blue reflex.
V.	$N\begin{cases}C^6H^5\\C^6H^3(NO^2)^2{}_m\\H\end{cases}$	$C^{12}H^9N^3O^4$	Clemm, $C^6H^3(NO^2)^2Br$ on $C^6H^5NH^2$. Long thin scarlet-red or red-yellow glittering needles. Fuses at 153°. Wilgerodt, α-$C^6H^3(NO^2)^2Cl$ on alcoholic H^2S-solution of aniline. Fuses at 156°–157°

* Ber. Chem. Ges., vii, 1399.

† The elimination of a group during nitrition is quite frequent. Tribrommethyldiphenylamine gives dibromtetranitrodiphenylamine [Gnehm] (Ber. Chem. Ges., viii, 930): tetrahydroisoxyloldicarboxyl (camphoric acid) yields trinitroisoxylol, under elimination of hydroxyl and carboxyl [Wreden] (ibid., v, 1106): many sulphonic acids part with the sulpho-group during nitrition. Cresolsulphonic acid gives trinitrocresol [Duclos] (Ann. Chem. Pharm., cix, 135) and dinitrocresol [Armstrong and Field] (Chem. News, xxvii, 318); dichlorphenolsulphonic acid yields a nitrochlorphenol [Armstrong] (Chem. Soc. Jour. [2], ix, 1112): monochlorphenolsulphonic acid, from solid chlorphenol, gives dinitrochlorphenol [Petersen and Baehr-Predari] (Ann. Chem. Pharm., clvii, 121): the monochlorphenolsulphonic acid from liquid chlorphenol behaves in a similar manner [Armstrong and Prevost] (Ber. Chem. Ges., vii, 404): sulphopodocarpinic acid yields dinitropodocarpinic acid [Oudemans] (ibid., vii, 1317). By nitrition of benzoylnaphthylamine, Hübner and Ebell (Ann. Chem. Pharm., clxx, 212) think they obtained a small amount of nitronapthylamine. In the nitrition residues of diphenyl, Fittig (ibid., cxxiv, 275) detected small amounts of nitrobenzol.

VI. $N\begin{cases}C^6H^5\\C^6H^3(NO^2)^2_a\\H\end{cases}$ $C^{12}H^6N^4O^6$ Do., $C^6H^3(NO^2)^2Cl$ on $C^6H^5NH^2$. Sparkling prisms. By reflection scarlet-red; by refraction reddish-yellow. Fuses at 175°.

VII. $N\begin{cases}C^6H^4(NO^2)_m\\C^6H^3(NO^2)^2_m\\H\end{cases}$ $C^{12}H^6N^4O^8$ Austen, $C^6H^3(NO^2)^2Br$ on *m*-nitraniline. Small glittering yellow crystals. Fuses at 189°.

VIII. $N\begin{cases}C^6H^4(NO^2)_p\\C^6H^3(NO^2)^2_m\\H\end{cases}$ $C^{12}H^6N^4O^6$ Do., $C^6H^3(NO^2)^2Br$ on *p*-nitraniline. Light electrical yellow powder. Easily soluble in cold glacial acetic acid. Fuses at 181°.

IX. $N\begin{cases}C^6H^4(NO^2)_m\\C^6H^3(NO^2)^2_a\\H\end{cases}$ $C^{12}H^7N^5O^8$ Do., $C^6H^2(NO^2)^2Cl$ on *m*-nitraniline. Heavy cryst. yellow sand, or wine-yellow transparent crystals. Fuses at 205°.

X. $N\begin{cases}C^6H^4(NO^2)_p\\C^6H^2(NO^2)^2_a\\H\end{cases}$ $C^{12}H^7N^5O^8$ Do., $C^6H^2(NO^2)^2Cl$ on *p*-nitraniline. Red crystalline powder, or glittering scales. Fuses at 216°.

XI. $N\begin{cases}C^6H^3(NO^2)^2\beta\\C^6H^2(NO^2)^2_a\\H\end{cases}$ $C^{12}H^5N^7O^{12}$ Do., nitrition of IX. Fuses at 261°. Impalpable bright yellow powder or small transparent glittering yellow crystals.

XII. $N\begin{cases}C^6H^3(NO^2)^2\gamma\\C^6H^2(NO^2)^2_a\\H\end{cases}$ $C^{12}H^5N^7O^{12}$ Do., nitrition of X. Small transparent glittering bright yellow prisms with green reflex. Fuses at 230°.

XIII. $Ba\begin{cases}N\begin{cases}C^6H^3(NO^2)^2\beta\\C^6H^2(NO^2)^2_a\end{cases}\\N\begin{cases}C^6H^2(NO^2)^2\beta\\C^6H^2(NO^2)^2_a\end{cases}\end{cases}$ $C^{24}H^8N^{14}O^{24}Ba$ Do., $Ba(OH)^2$ on XI. Dark saffron-red glittering needles. Explodes on heating.

XIV. $N\begin{cases}C^6H^2(NO^2)^3?\\C^6H^2(NO^2)^3?\\H\end{cases}$ $C^{12}H^5N^7O^{12}$ Gnehm, nitrition of diphenylamine. Transparent light-yellow prisms. Fuses at 238°.

XV. $N\begin{cases}C^6H^2(NO^2)^3?\\C^6H^2(NO^2)^3?\\NH^4\end{cases}$ $C^{12}H^8N^8O^{12}$ Do., NH^3 on XIV. Beautiful red leaves.

XVI. $N\begin{cases}C^6H^2Br(NO^2)^2?\\C^6H^2Br(NO^2)^2?\\H\end{cases}$ $C^{12}H^5N^5Br^2O^8$ Do., nitrition of $HN\begin{cases}C^6H^4Br\\C^6H^3Br^2\end{cases}$. Yellow pearly leaves or rhombic tablets. Fuses at 235°–240°–242°.

XVII. $N\begin{cases}C^6H^2(NO^2)^2Br?\\C^6H^5\\H\end{cases}$ $C^{12}H^6N^3BrO^4$ Austen, $C^6H^5.NH^2$ on $C^6H^2\begin{cases}(NO^2)^2\beta\\Br^2_p\end{cases}$ Beautiful red-orange, fine hairy needles. Fuses at 120°. (This Journal, xii, 118.)

XVIII. $N\begin{cases}C^6H^2(NO^2)^2Br?\\C^6H^3(NO^2)^2?\\H\end{cases}$ $C^{12}H^5N^5BrO^8$ Do., nitrition of XVII. Small brown scales. Fuses at 167·5°.

XIX. $N\begin{cases}C^6H^3(NO^2)^2?\\C^6H^4.C^6H^4.NH^2?\\H\end{cases}$ $C^{16}H^{14}N^4O^4$ Wilgerodt, α-$C^6H^3(NO^2)^2Cl$ on benzidine. Short bluish brown-red needles. Fuses at 255°. (Ber. Chem. Ges., ix, 977.)

XX. $N\begin{cases}C^6H^3(NO^2)^2?\\C^6H^4.C^6H^4.NH\ C^6H^3[(NO^2)^2]\\H\end{cases}$ $C^{24}H^{16}N^6O^8$ Do., formed with XIX. Yellow pulverulent. Sol. in conc. H^2SO^4 with a violet color. Fuses at 330°.

XXI. $N\begin{cases}C^6H^3(NO^2)Clm\\C^6H^5\\H\end{cases}$ $C^{12}H^9N^2ClO^2$ Laubenheimer. Action of $C^6H^3(NO^2)Cl^m$. NO^2 on aniline. Long glittering alizarine-red needles. Fuses at 108·5°.

University Laboratory of Berlin, August 30, 1876.
(School of Mines, New York, January 3, 1877.)

ART. XXXIII.—*Note on Mineral Analysis; Notes upon some Fluorides; and Note on Molecular Volumes;* by F. W. CLARKE, S.B., Professor of Physics and Chemistry.—*Laboratory Notes from the University of Cincinnati.* Nos. I to III.

I. *Note on Mineral Analysis.*

IN 1868,* the writer called attention to the fact that certain very refractory minerals are easily rendered soluble by fusion with a mixture of sodium fluoride and acid potassium sulphate. He now finds that in many cases, and with but little loss of power, common salt may replace the fluoride, the mode of manipulation remaining the same. The finely pulverized mineral is to be mixed with three parts of the chloride in a capacious platinum crucible, and the mixture covered with twelve or fifteen parts of the acid sulphate in small fragments. The fusion is then performed over an ordinary Bunsen's flame, and in five or six minutes is complete. The fused mass, after cooling, detaches readily from the crucible, and shows upon its smooth under surface no traces of undecomposed assay.

This method is not by any means equal to the original process with sodium fluoride, either in speed or in generality of application; still, in some cases, it is convenient. Sodium fluoride is expensive, and not always immediately to be obtained; hence the desirability of a substitute. Perhaps my new observation might better be stated thus: that whenever a mineral is resolvable by fusion with the acid sulphate alone, the action is very much facilitated by the addition of common salt.

The new fusing mixture will probably prove to be most serviceable in the analysis of refractory iron ores and of chromite. The latter mineral, after fusion with chloride and bisulphate, furnishes a green mass completely soluble in dilute hydrochloric acid. Or this mass may be treated directly with strong nitric acid and potassium chlorate, after the method of Storer and Pearson, and all the chromium oxidized at once to chromic acid. Precipitation of the chromium as mercurous chromate is then possible, but not wholly convenient. Several unsuccessful efforts were made to carry out the oxidation of the chromium in the course of the fusion itself. With the sodium fluoride or chloride, sodium nitrate or potassium chlorate was mixed. Then upon fusing with the acid sulphate, partial oxidation ensued, but in no case did more than a small fraction of the chromium seem thus to be affected.

* This Journal, March, 1868.

II. *Notes upon some Fluorides.*

Nickel fluoride.—This salt was prepared by dissolving nickel hydrate in aqueous hydrofluoric acid. Upon concentrating the dark green fluid a granular mass of crystals separated out; which, according to water determinations made by Mr. John Hagemann, had the composition $NiF_2.3H_2O$. The last portions of water were retained up to the temperature of 130°. Percentage of water found, 35·98; calculated, 35·81. Specific gravity, 2·014 at 19°. The anhydrous fluoride, NiF_2, had the density 2·855 at 14°. These specific gravity determinations were made in an ordinary specific-gravity bottle, chloroform being the liquid employed.

On two accounts these observations are interesting. First, because the hydrated salt is evidently new, the crystallized nickel fluoride described by Berzelius having contained but two molecules of water. Secondly, the molecular volume of the water in this new hydrate is 13·65; corresponding very closely with the average value of 13·76, deduced by the writer from the study of over thirty different salts, and stated in his paper of two years ago.*

Attempts to prepare a double fluoride of nickel and silver met with but indifferent success. In several experiments the mixed solutions of the two fluorides yielded upon concentrating only the nickel salt alone; the silver compound apparently decomposing. In one instance, however, pale apple-green needles were deposited, mixed with some microscopic rhombohedrons. Upon recrystallizing, about two-tenths of a gram of these crystals were obtained, both forms being represented, and, to the naked eye, both consisting of one and the same substance. A qualitative examination showed them to be a true double fluoride of nickel and silver, highly hydrated; but not sufficient in quantity for a thorough analysis. The silver in them amounted to a trifle less than twenty per cent, a proportion which agrees with no probable formula.

Zinc fluoride.—The only new fact for me to record concerning this salt is its density. Two distinct samples of the crystallized compound, $ZnF_2.4H_2O$, obtained from a solution of zinc in hydrofluoric acid, gave respectively 2·567 at 10°, and 2·535 at 12°. The anhydrous fluoride gave in one experiment a specific gravity of 4·556 at 17°, and in another 4·612 at 12°. These figures are noticeable from the fact that they do not agree with the usual molecular volume of water of crystallization. They yield a volume of water ranging from 11·4 to 11·8; an amount considerably below the usual value. I will not now hazard any conjectures as to the meaning of this apparent exception.

* This Journal, December, 1874.

The writer has also determined the specific gravities of several alkaline fluorides, as follows: Lithium fluoride, 2·295, 21·5°; sodium fluoride, 2·558, 14·5°; potassium fluoride, 2·096, 21·5°. According to Bödeker, potassium fluoride has a density of 2·454 at 12°. Theoretical considerations, to be cited in the third part of this paper, sustain the lower value as obtained by me. An examination of rubidium fluoride, made upon a very small quantity of material, may not prove to be wholly trustworthy. It gave a specific gravity of 3·102 at 17°. Rubidium carbonate was dissolved in hydrofluoric acid, the solution evaporated to dryness in a platinum dish, and the residue fused at a heat just below redness. The molten fluoride was so transparent as to be almost invisible in the vessel containing it; but, upon cooling, it became white and opaque, and contracted so strongly as to split up into several fragments. This salt is extremely deliquescent.

Attempts to prepare fluorides of gold and platinum were wholly unsuccessful. Still, results were obtained which may be worth recording. To a solution of gold chloride, silver fluoride was added, in order that by double decomposition silver chloride might be thrown down and gold fluoride formed. In fact, however, there fell a pale-brown precipitate which grew rapidly darker in color, and which consisted of silver chloride mixed with gold oxide. The reaction may be expressed as follows:

$$2AuCl_3+6AgF+3H_2O=Au_2O_3+6AgCl+6HF.$$

With platinum tetrachloride and silver fluoride a pale-yellow precipitate was formed, containing platinum dioxide, thus:

$$PtCl_4+4AgF+2H_2O=PtO_2+4AgCl+4HF.$$

The same precipitates are formed when silver nitrate is used instead of fluoride, nitric acid being set free in place of hydrofluoric. This has long been known, the reactions being new only in so far as they involve the effect of silver fluoride. This statement is made so that perhaps some other investigators may be saved from tedious and fruitless experimenting.

III. *Note on Molecular Volumes.*

Several years ago, in a series of papers upon atomic or molecular volumes, I pointed out some curious multiple relations connecting both elements and compounds.* For example, I found that a simple relation of this kind connected the alkaline metals with each other; and, later, that the haloid salts of some of these metals had molecular volumes multiples of that of hydrogen. For this latter relation, however, my materials were meager. I had then the specific gravity determinations

* This Journal, March and May, 1869; September, 1870.

for LiCl, NaCl, KCl, NaBr, KBr, NaI, and KI, or seven compounds in all. To these I added, though unsatisfactorily, the corresponding salts of silver, making a list of ten bodies closely related, and giving volumes multiples of 5·5, the value assigned by Kopp to hydrogen in its liquid compounds, at their boiling points. This relation I am now able to extend, partly by new density observations of my own, to include at least twelve compounds not in my earlier list.

My own determinations, in addition to those I have already given for the alkaline fluorides, are as follows: Rubidium chloride, 2·209, 19°; rubidium bromide, 2·780, 17·5°; rubidium iodide, 3·023, 22°; lithium bromide, 3·102, 17°; lithium iodide, 3·485, 23°.

Now let us tabulate the material. The first column contains the symbol of the substance, the second its density with authority given, the third its molecular volume as found, the fourth its volume calculated, the fifth a theoretical density deduced from this volume. The calculated volumes are of course the exact multiples of Kopp's hydrogen value, and will be seen at once to agree closely with the results of experiment. The real variation between fact and theory, however, will be best seen upon comparing the two columns of densities. The differences here are always less than 0·1.

I.	II.	III.	IV.	V.
Li F.	2·295, Clarke.	11·33	11·00	2·363
Li Cl.	1·998, Kremers.	21·27	22·00	1·932
Li Br.	3·102, Clarke.	28·05	27·50	3·164
Li I.	3·485, "	38·45	38·50	3·481
Na F.	2·558, "	16·41	16·50	2·545
Na Cl.	2·145, Buignet.	27·27	27·50	2·127
Na Br.	3·079, Kremers.	33·45	33·00	3·121
Na I.	3·450, Filhol.	43·48	44·00	3·409
K F.	2·096, Clarke.	28·20	27·50	2·113
K Cl.	1·945, Kopp.	38·35	38·50	1·937
K Br.	2·672, Playfair, Joule.	44·57	44·00	2·707
K I.	3·056, Filhol.	54·35	55·00	3·020
Rb F.	3·202, Clarke.	32·64	33·00	3·167
Rb Cl.	2·209, "	54·78	55·00	2·200
Rb Br.	2·780, "	59·53	60·50	2·735
Rb I.	3·023, "	70·29	71·50	2·972

Here now we have sixteen compounds of a single type, every one of which agrees with the rule. In each case the molecular volume comes out a multiple of 5·5, or very nearly. Only one substance in the list seems to be in any way abnormal, namely, rubidium fluoride, with its volume of 33. The other fluorides in this group have volumes less by 11 than those of the corresponding chlorides, but in this case the difference is 22. A curious progressive relation is also worth noting. If

we compare the five chlorides given in the table we shall see that upon arranging them in the order of their molecular weights the differences between successive members of the series increase as we ascend. Thus LiCl and NaCl differ by 5·5, NaCl and KCl by 11, KCl and RbCl by 16·5. This regular difference-increase is certainly suggestive of some law yet to be clearly made out.

A similar relation to Kopp's hydrogen volume is also afforded by the two other compounds. Sodium hydride, Na_2H, discovered by Troost and Hautefeuille,* with a density of 0·959, has a molecular volume of 49·1, or very nearly $5·5 \times 9$. Still more interesting is iodine monochloride, so carefully studied by Hannay.† At 0° the solid substance has a specific gravity of 3·263, and a molecular volume of 49·8, thus varying only 0·3 from a multiple of 5·5. At 101° the chloride boils, and at 98° its density is 2·958, having a volume of 54·9. Probably an absolutely correct determination at its boiling point would give a value of 55. So we may say that iodine monochloride, both as a solid at 0°, and as a liquid at its boiling point, has molecular volumes multiples of that of hydrogen.

As for the haloid salts of silver, they cannot with certainty be included among the substances connected by this multiple relation. The fluoride agrees fairly, however, having a density of 5·852, Gore, and a molecular volume of 21·7 instead of 22. The chloride and iodide may be forced to agree by selecting out the density determinations of certain investigators, and rejecting other decidedly discordant data. The bromide does not agree at all. A determination of my own for precipitated AgBr gives a density of 6·215, 17°, and a corresponding volume of 30·25. Other determinations are even more discordant than this. Silver salts generally have molecular volumes equal or nearly equal to the corresponding sodium compounds; that of sodium bromide being 33·0. Silver fluoride, it will be seen, diverges also from the sodium salts. For thallium, our data are insufficient. Its monochloride has a molecular volume approximating to a multiple of 5·5, but not closely enough to be satisfactory. The sesquichloride does not even approximate. At some future time I hope to be able to revise and extend our specific gravity determinations for this class of thallium salts.

Now to sum up. Including the silver and thallium salts we know the densities of twenty-five substances containing only univalent elements. Of these, twenty have molecular volumes multiples of that of hydrogen, three are doubtful, two apparently disagree. We may, therefore, safely assert the following general law, subject to possible exceptions. *Every compound*

* Compt. Rend., vol. lxxviii, 970. † Jour. Chem. Soc., II, xi, 818.

containing only elements of the hydrogen group has a molecular volume an even multiple of that of hydrogen. This is probably but a hint of some more general regularity connecting other elements and other groups.

Postscript.—Since the above pages were written, there has been published by Johnson a density determination for potassium triiodide, KI_3. (Chem. News, xxxiv, 256.) This determination, 3·498, corresponds to a molecular volume of 120·1. 121 is an exact multiple of 5·5, and gives a theoretical density of 3·472. The multiple relation now holds good in twenty cases out of twenty-five.

ART. XXXIV.—*On the identity of the so-called Peganite of Arkansas with the Variscite of Breithaupt and Callainite of Damour;* by ALBERT H. CHESTER.

A NUMBER of years ago I obtained some specimens of a mineral, said to come from Colorado, which, after a hasty examination, was called peganite. More recently, I have received specimens of the same mineral from Montgomery County, Arkansas, from which locality the first undoubtedly came. Analyses were made of both, with the results given below; No. 1 is of the amorphous mineral, and No. 2 is the average of two analyses of the crystalline variety. It was found impossible to separate it from the quartz with which it is associated, and a considerable quantity of the latter substance is unavoidably included in each analysis.

	1	2
Phosphoric acid	13·08	22·36
Alumina	9·59	15·72
Water	7·08	11·89
Insoluble residue	69·69	49·86
Total,	99·44	99·83

Deducting the insoluble residue, and calculating to one hundred per cent, we have the results below in columns 1 and 2, while 3 gives the average of the two, and 4 the oxygen ratio.

	1	2	3	4
Phosphoric acid	43·96	44·74	44·35	5·05
Alumina	32·24	31·46	31·85	3·00
Water	23·80	23·80	23·80	4·32

In four other analyses the ratio of water to phosphate of alumina was found to be 1 to 4·04, 4·26, 4·01, and 4·23. The formula for the mineral must then be Al_2O_3, $P_2O_5+4H_2O$, making it distinct from peganite, with which it has been con-

founded. Its composition, moreover, is identical with that obtained by Petersen for the variscite of Breithaupt, and closely corresponds to that of the callais (callainite) of Damour. Analysis 1, below, is by Petersen (Jahrb. Min., 1871, 357) of variscite from Messbach, in Saxon Voigtland; and analysis 2, one given by Damour (after the deduction of 2·10 p. c. of sand), of callais:

	1	2
Phosphoric acid	44·05	43·31
Alumina	31·25	30·09
Iron sesquioxide[1]	1·21	1·86
Magnesia	0·41	
Lime	0·18	0·70
Water	22·85	24·04
Total,	99·95	100·00

[1] With Cr_2O_3 and FeO.

Both of these analyses agree closely with the formula given, Al_2O_3, $P_2O_5+4H_2O$, which requires: phosphoric acid 44·80, alumina 32·49, water 22·71=100. The mineral from Arkansas with also the callainite of Damour should consequently be included under the name *variscite*, given in 1837 by Breithaupt.

The mineral occurs in crystalline crusts on quartz; also rarely in distinct crystals of very small size. These belong to the orthorhombic system, showing prismatic and basal planes. The crust often presents a semi-globular form with a radiated structure. It also occurs amorphous and disseminated through quartz. The colors observed are deep emerald-green, though all shades of bluish green to almost colorless. Some crystals are dark in the middle, and light at both ends. It is transparent to translucent, infusible, and has a hardness of about 4. Before the blowpipe it becomes opaque, friable, and of a deep purple when hot, lighter purple when cold. In the glass tube yields much water and changes in color as above.

Chemical Laboratory, Hamilton College, Clinton, N. Y., Feb. 12.

ART. XXXV.—*On a fibrous variety of Sepiolite from Utah;* by ALBERT H. CHESTER.

SOME years since I obtained, while visiting a silver mine in Utah, specimens of a fibrous mineral which upon analysis proves to have the composition of sepiolite. It occurs in a seam about two inches in thickness cutting across the rock strata and vein at nearly right angles. The following analyses give the composition of two varieties, one of which is white, and the other bluish-green; 1 is the mean of four analyses of

the white variety; 3 is a single analysis of the green kind; and 2 and 4 are the respective oxygen ratios for the two.

	1	2	3	4
Silica	52·97	6·16	50·15	6·08
Alumina	0·86		2·06	
Iron sesquioxide	0·70		1·02	
Manganese sesquioxide	3·14		2·09	
Copper oxide	0·87	2·	6·82	2·
Magnesia	22·50		18·29	
Water	9·90	1·92	9·30	1·88
Moisture	8·80		10·32	

One half the water is driven off at a temperature of 100° C., and very little more is lost even up to 200° C., and a full red heat is required to expel the last traces. It is hence probable that the moisture which goes off below 110° does not belong to the mineral and should not be regarded in deducing the formula. The formula obtained is $2MgO, 3SiO_2 + 2H_2O$, which is identical with that of sepiolite, of which it is a new and interesting variety. Its blowpipe characters, and its behavior with acids are the same as those of sepiolite. It gelatinizes with hydrochloric acid though not entirely decomposed. The green variety, as shown in the analysis above, contains considerable copper, which is obviously the cause of the color, and which seems to replace the magnesia in the composition of the mineral.

Hamilton College, Feb. 14.

ART. XXXVI.—*On Dr. Peale's Notes on the Age of the Rocky Mountains in Colorado;* by J. J. STEVENSON, Professor of Geology in the University of New York.

I HAVE read Dr. Peale's notes with a good deal of care, but his long discussion of my conclusions contains very little in the way of direct argument, which seems to me to call for a reply. At the same time it is necessary to correct some of Dr. Peale's statements, which, no doubt without any such intention on his part, certainly tend to give a false impression respecting both my facts and my position.

The first of these is on page 172, where the final sentence in the third paragraph seems to intimate that while Dr. Peale does not regard his data as sufficient to extend his generalizations to the entire Rocky Mountain System, I, on the other hand, feel no similar hesitation respecting my data, which were procured within a smaller area. The opening paragraph of Chap. XVII of Wheeler, vol. iii, contains a full statement of my opinion concerning the value of my data.

The second of these is on page 174, in the third paragraph. There the statement is made that the Trias is present in southwestern Colorado and northern New Mexico, and the testimony of Dr. Newberry, Prof. Cope, Mr. Holmes and Dr. Peale is offered to prove the truth of the statement. This effort to show the existence of the Trias there, taken in connection with the fact that no reference is made to my mention of the group in that region, is very apt to leave the impression either that I failed to recognize the group or that I had denied its existence; which would be an error in each case. The occurrence of the Trias in that region is used as a strong proof that Trias occurs in the interior in opposition to my assertion that the group is absent in the interior. With all due respect for Dr. Peale's judgment, I submit that the presence or absence of Trias in New Mexico or southwestern Colorado has nothing to do with the "interior," as those districts are outside of the flexed region, which I called the "interior."

The third of these is on page 176, but begins at the bottom of page 175, where the statement is made that my conclusions in favor of upheaval at the close of the Trias, are based upon unconformability observed at Golden, near Colorado Springs, near Cañon City, and also in Huerfano Park. Dr. Peale at once settles the question here by showing that there is no proof of non-conformability at either Golden or Colorado Springs, so that, as I had made a mistake at each of these localities, there is every reason to believe that the same mistake was made at the other localities. Now I grant him all he says about the conditions at Golden and Colorado Springs; the groups are not in direct contact there, and consequently no proof of non-conformability can be found. But that does not concern this matter in any way. As I made no reference to either Golden or Colorado Springs in this connection, I, of course, made no mistake respecting them, so that Dr. Peale's intimation with regard to the localities to which I did refer, is wholly gratuitous.

The fourth of these statements is in the paragraph beginning at the bottom of page 179, and continuing almost to the bottom of page 180. The reasoning in this paragraph may be ingenious, but one would find difficulty, even by the use of the utmost courtesy, in calling it ingenuous. For the sake of avoiding confusion, as well as for the sake of courtesy, it would have been "best to state" in the text that "Prof. Stevenson regards as Cretaceous" the debatable lignite group which Dr. Peale regards as Lower Tertiary. Buried, as this statement is, in the foot notes, it is easily overlooked, and the remark on the following page "that there was no marked action until the close of the Lignitic," in connection with the

context, readily appears to contradict the quotation from my report on page 179. But there is no difference between Dr. Peale and myself. When I wrote that chapter in 1874 I regarded the whole Lignitic group as forming the closing portion of the Cretaceous. So I considered the period of accelerated upheaval as occurring at the close of the Cretaceous, that is, at the close of the Lignitic group. Dr. Peale places the action at the same time.

I have no additional facts to offer in support of the provisional conclusions which I offered in the report to Lieut. Wheeler. All the material in my possession is given in that report, and the synopsis of that, which seemed to have a bearing on the age of the system, is to be found in Wheeler, vol. iii, Chap. XVII. Nor am I likely to secure any additional facts either *pro* or *con*, as there is no probability that I shall have an opportunity to revisit the Rocky Mountains for a number of years.

New York, March 9th, 1877.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Velocity of Chemical Reactions.*—Boguski and Kajander have continued the experiments commenced by the former to ascertain the velocity of chemical reactions. Boguski defines velocity of reaction by supposing that $u=f(a_1, a_2, a_3, \ldots\ldots a_n, t)$, in which u is the quantity of the new body produced in the time t, and $a_1, a_2, a_3 \ldots\ldots a_n$ the conditions under which the reaction takes place. Hence the first differential coefficient, $\frac{du}{dt} f=(a_1, a_2, a_3 \ldots a_n, t)$ represents the reaction-velocity under the conditions given. It remains to find the form of the functions u and $\frac{du}{dt}$. Since all the conditions must be exactly measurable and expressible in numbers, the author chose for experiment the action of liquids on solids, in which the only variables—the temperature being constant—are the surface of the solid acted on and the concentration of the solution. "Concentration" is used to express the value given by the formula $D.\frac{1}{M}.\frac{p}{100}$, in which D is the sp. gr. of the solution, p the percentage content of the body dissolved and M its molecular weight. Since the number of molecules of this body in a unit of volume of the solution is directly proportional to this value, if V represent the volume in c.c., the formula $V.D.\frac{1}{M}.\frac{p}{100}=y$ represents the concentration

used in the experiment. Two modes of stating the results are proposed: 1st, that the quantity of the new body formed in an infinitely short time is proportional to the concentration y at that time; or 2d, that this quantity is proportional to the number of molecules of the liquid which act upon a unit of surface of the solid. Taking the reaction between zinc and sulphuric acid, and assuming that a unit of zinc surface dips in a unit of volume of the acid, the first hypothesis is expressed by the differential equation $d[H_2]=kydt$, in which $d[H_2]$ expresses the quantity of hydrogen set free in the infinitely small time dt, and k is the proportional coefficient. Since 49 parts of H_2SO_4 are required to evolve 1 part of H, we have $[H_2]=-\frac{1}{49}[H_2SO_4]=-\frac{1}{49}y$. Differentiating, $d[H_2]=-\frac{1}{49}dy$. Equating with this the above expression for $d[H_2]$, we have $\frac{dy}{y}=-49kdt$. By integration between the limits y_t and y_0, the value of y_t can be obtained; and by substituting this value for y in the first equation given above, changing the signs and integrating between corresponding limits, $\int_0^{[H_2]} d[H_2]=ky_0\int_0^t e^{-\frac{1}{49}kt}dt$, there is obtained $[H_2]=\frac{1}{49}y_0(1-e^{-\frac{1}{49}kt})=\frac{1}{49}(y_0-y_t)$, from which $k=\frac{1}{t}\cdot\frac{1}{49}\cdot\frac{1}{M}$ comm. log. $\frac{y_0}{y_t}$. The experimental results with zinc and sulphuric acid not being uniform, the author took Carrara marble and hydrochloric acid, the marble parallelopipeds being accurately measured. From this the surface-area was calculated and also the volume of liquid required to give a unit of volume to each unit of marble surface. The concentration of the acid was determined volumetrically, giving y_0. The carefully weighed marble was placed in the acid for a known time, then removed, washed, dried and weighed; from the loss, the carbonic dioxide evolved and the acid consumed were determined, giving y_t. From these data, by the formula $t=\frac{73}{44}kM\log\frac{y_t}{y_0}$, the value of $\frac{73}{44}kM$, and consequently of k, was calculated. As a mean of 53 well agreeing experiments, the value of $\frac{73}{44}kM$ was found to be 0·01765, and of k 0·0444±0·003 at 20° and 760 mm. Since this value is constant, it follows that the first supposition represents a fact, and that the quantity of carbon dioxide gas evolved from marble in a definite moment of time is directly proportional to the concentration of the acid at that moment. In connection with Kajander, Boguski has now extended the investigation to other acids, using nitric and hydrobromic in the new experiments. They find the values $\frac{126}{44}kM$ and $\frac{162}{44}kM$ respectively 0·0175, and 0·0185, being sensibly the same as that above given; hence the coefficient k, for these three acids is inversely proportional to their molecular weights. From the equation $d[CO_2]=kydt$, we have the velocity of the reaction $v=\frac{d[CO_2]}{dt}=ky$. Consequently when different acids of the same

concentration act upon marble, the velocity of evolution of carbon dioxide is inversely proportional to their molecular weights.—*Ber. Berl. Chem. Ges.*, ix, 1646, x, 34, Jan. 1877. G. F. B.

2. *On the Equivalence of Nitrogen.*—LADENBURG and STRUVE have sought to throw some light upon the equivalence of nitrogen by studying carefully and comparing directly the properties of triethylbenzylammonium chloride and iodide on the one hand, and those of benzyltriethylammonium chloride and iodide on the other. The former bodies were prepared directly by acting on triethylamine with benzyl chloride in a sealed tube at 100°. A white crystalline mass results, which is soluble in water, and is easily crystallized therefrom. The platinum double chloride crystallizes easily from hot water, and has the formula $(N(C_2H_5)_3 C_7H_7Cl)_2PtCl_4$. The iodide, obtained by the action of silver oxide and hydriodic acid on the chloride, when its solution is evaporated on the water-bath, is very readily decomposed, yielding irritating odors of benzyl iodide. The second bodies were obtained by acting on benzylamine with ethyl iodide at 130°. The platinum double chloride gave the formula $(NC_7H_7(C_2H_5)_3 Cl)_2PtCl_4$. When, however, aqueous solutions of benzyltriethylammonium iodide are evaporated on the water-bath no benzyl iodide is formed even when the evaporation is carried to dryness. This difference in the behavior of the two bodies leads the authors to regard them as isomeric and not identical. The same conclusion is drawn from the form of crystallization of the platinochlorides, one being apparently monoclinic, the other orthorhombic. From this it follows that the five bonds of nitrogen in ammonium chloride have not all the same value.—*Ber. Berl. Chem. Ges.*, x, 43, Jan. 1877. G. F. B

3. *Action of fuming Nitric acid on Coal Gas.*—AKESTORIDES has studied the products obtained from coal gas by passing it through fuming nitric acid, until a brown layer separated and crystals began to appear. The heavy layer evolved on heating torrents of nitrogen tetroxide gas, and on adding water, a yellow nitro compound separated which was not examined. The crystals consisted of oxalic acid. The lighter fluid, which had the odor of nitrobenzene, consisted essentially of two nitro-compounds, one boiling at 205°, the other at 222°, being nitrobenzene and nitrotoluene. A small quantity of a third body, boiling about 300°, was obtained, probably a nitro-naphthalene. In examining for the source of the production of oxalic acid, the author found that benzene gave none when treated with fuming nitric acid, while toluene and xylene gave small quantities, and ethylene afforded it abundantly. Hence the author concludes, contrary to Berthelot's opinion, that ethylene is absorbed by nitric acid and is oxidized to oxalic acid; this substance being permanent even in fuming acid.—*J. pr. Ch.*, II, xv, 62, Jan. 1877. G. F. B.

4. *On oxidized Platinic sulphide.*—E. v. MEYER has examined the so-called oxidized platinic sulphide, long known for its special catalytic activity. It was prepared by precipitating a hot solu-

tion of potassium platino-chloride by hydrogen sulphide, washing the precipitate by decantation with hot water, and drying for several days on the water-bath, during which latter process the oxidation takes place. It appears as a heavy black powder, which on continuous heating at or above 100° suffers further oxidation. If the heating be rapid, oxygen is absorbed, sulphurous and sulphuric oxides are formed, and platinum is left. On examination it was found to contain the elements of water; and upon analysis two products were distinguished, one the normal hydrate $PtS\left\{\begin{matrix}OH\\OH\end{matrix}\right.$, the other derived from two molecules of this by the loss of water, $\begin{matrix}PtS\\PtS\end{matrix}\Big\}O\begin{matrix}OH\\OH\end{matrix}$. The analytical results for the latter were satisfactory; but the former could not be obtained as pure. The sulph-oxide (PtS)O does not appear to exist free. The author finds the body to be an energetic oxidizer, H_2S yielding S, SO_2 giving SO_3, HCl evolving Cl, NH_3 producing HNO_2 and HNO_3, oxalic acid giving CO_2, ferrous being oxidized to ferric salts, alcohol to aldehyde and toluene yielding benzaldehyde.—*J. pr. Ch.*, II, xv, 1, Jan. 1877. G. F. B.

5. *Preparation of Glycollic acid by reduction of Oxalic acid.*—Crommydis has succeeded in producing glycollic acid from oxalic, by the action upon it of nascent hydrogen. The oxalic acid dissolved in water, was mixed with zinc turnings and heated for eight days in a water-bath. The liquid was then filtered, treated with milk of lime, again filtered, the excess of lime removed by oxalic acid, boiled to destroy the glyoxylate, again filtered, and evaporated to crystallization. On cooling, crystalline warty masses formed which were soft like wax, and which on analysis proved to be calcium glycollate, crystallized with four molecules of water. The copper and zinc salts were also prepared and examined.—*Bull. Soc. Ch.*, II, xxvii, 3, Jan. 1877. G. F. B.

6. *On the Decomposition of the Oil of Turpentine at high Temperatures.*—Schultz has studied the products of the action of high temperatures upon oil of turpentine, using iron tubes and heating them in a Hofmann furnace to a dull red heat. The oil distilled between 158° and 161°, and was caused to flow into the heated tube drop by drop. Carbon was deposited, combustible gases were evolved which were not examined, and a black tar collected in the well-cooled receiver connected with the apparatus. This tar was fractionated, and the fractions examined. The portion boiling below 200° afforded benzene, toluene and xylene; that below 300°, naphthalene; and that above 300°, phenanthrene, anthracene and methyl-anthracene.—*Ber. Berl. Chem. Ges.*, x, 113, Feb. 1877. G. F. B.

7. *Constituents of Beech-wood Tar-creosote.*—Tiemann and Mendelsohn have examined the properties of creosol and phlorol, constituents of that fraction of beech-tar creosote boiling near 220°. By the action of acetic oxide on potassium-creosol, acetyl-creosol is obtained, and this by oxidation and removal of the

acetyl, gives vanillic acid. Creosol is therefore parahydroxyl-metamethoxyl-toluene. From phlorol, methyl-phlorol and oxyphthalic acid were prepared.—*Ber. Berl. Chem. Ges.*, x, 57, Jan. 1877. G. F. B.

8. *Measurement of High Pressures.*—M. L. CAILLETET has recently constructed a manometer capable of measuring high pressures, on the slope of a hill near his laboratory at Chatillon-sur-Seine. The apparatus consists of a metallic tube 70 meters long and about 2 mms. interior diameter. One of the extremities of this tube is soldered to a reservoir of iron filled with mercury and placed at the base of the hill. To the free extremity of the tube a large glass tube is attached, which forms the upper end. When the mercury contained in the reservoir is compressed, it is forced up into the metallic tube so as partly to fill the glass tube, which is fixed on a vertical plate. This portion of the apparatus is movable, owing to the flexibility of the metallic tube and may be carried to one side and placed against either of several stakes arranged along the slope and having indices distant from each other exactly 760 mms. vertically. Fractions of an atmosphere are measured by a graduated scale resting against the stake. Attached thermometers give the correction for temperature. A pressure of thirty-four atmospheres may thus be obtained. M. Cailletet proposes shortly to measure the compressibility of gases at very high pressures by the aid of the shaft of a deep mine. For this purpose it is only necessary to lower into the shaft to a known depth a cylindrical reservoir of iron about two meters long and containing the apparatus with gilt glass he previously used in testing the law of Mariotte. A small metal tube starting at the surface is attached to the iron reservoir. When mercury is turned into the extremity of the metallic tube, it descends into the reservoir and produces a pressure which is transmitted to the gas in the interior. This pressure is accurately measured by the difference of level of the mercury in the two tubes. Thus with no special apparatus and simply by the aid of mercury we can compress a gas several hundred atmospheres and at the same time measure exactly the pressure produced.—*Comptes Rendus*, lxxxiv, 83. E. C. P.

9. *Diathermaneity of Metals and Paper.*—M. AYMONNET, from his own observations, together with those of Wiedemann and Franz, on the rapidity with which the equilibrium of temperature is established in bars whose coefficients of conductibility are sought, arrives at the following conclusions:

1st. That metals and paper are not athermanous as is generally supposed.

2d. That they are more diathermanous for the obscure rays emanating from metallic bodies brought to a temperature below 100° than for the luminous heat rays, or those near the red end of the spectrum.

3d. That they have absorbent powers less than that of water. The complement of the inverse ratio which exists between the

quantity of heat which penetrates normally into a body and that which goes out of it in the same direction is here called the absorbent power.

4th. That it is possible to find a mathematical relation between the absorbent power of a body and its coefficient of conductibility. *Comptes Rendus*, lxxxiv, 259. E. C. P.

10. *Increase of Weight by Combustion.*—M. V. MEYER suggests a form of lecture-room experiment to show the increase of weight in the combustion of a substance at the expense of the oxygen of the air. Some years ago Professor Hoffmann showed a practical method of demonstrating experimentally the increase of weight of iron when burned in oxygen, but there has been as yet no simple means of proving this fact for objects like a candle, which appear to the eye to diminish. A candle is attached to each pan of a balance, and above one a glass tube open at both ends is hung, at nearly the height of the wick. In this tube is a piece of wire gauze holding some pieces of caustic soda; after balancing the candles, one of the candles is lit, when the products of combustion are retained by the soda and this end of the beam descends. At the end of a quarter of an hour the difference in weight may amount to three grams.—*Ber. Chem. Gesell.*, ix, 1866; *Bib. Univ.*, ccxxix, 106. E. C. P.

11. *Absorption of Light.*—M. LIPPICH of the Vienna Academy has recently been investigating the influence of the mean distance of absorbent particles upon absorption. As such an influence must be especially prominent when the substances afford well-defined absorption bands, and, with considerable density, show no strong colors, he chose for his experiments the nitrate of didymium oxide, which has these properties in a high degree. A pretty concentrated aqueous solution of this salt in a vessel one centimeter thick was spectroscopically compared with a solution having a concentration of only 0·1, 0·05 of the first. These solutions were in tubes of ten and twenty centimeters severally. A Steinhiel spectroscope was used, and the light sources were two gas lamps so regulated that both spectra showed the same brightness on the parts that were free from absorption. Even with the concentration ratio 1·10, there were marked differences in the absorption bands. The very characteristic bands in the yellow and yellow-green were, for the more concentrated solution, considerably broadened toward the red end of the spectrum, while the sharp limit toward the violet was the same for both solutions. The much narrower bands in the green showed quite a similar behavior. In the other parts differences were observed with difficulty. Besides this difference in the breadth of the absorption bands, there were others in the distribution of the bright parts.—*Nature*, xv, 208. E. C. P.

12. *Lippmann's Electrometer.*—Professor DEWAR exhibited to the Physical Society a simple electrometer which he has designed, founded on the discovery of Lippmann that the capillary constant is not really independent of the temperature or condition of the

surface, but is a function of the electromotive force. If a capillary tube be immersed in mercury, and dilute sulphuric acid be placed in the tube above the mercury, and a current from a Daniell's cell be so passed through the liquids that the mercury forms the negative pole, the column will be depressed to an extent dependent on the diameter of the tube. In making an electrometer, Professor Dewar has increased the sensitiveness by connecting two vessels of mercury by means of a horizontal glass tube filled with the metal, except that it contains a bubble of dilute acid. The tube must have an internal diameter of two millimeters, and it is essential that it be perfectly clean, uniform in diameter and horizontal. The instruments exhibited were constructed by Messrs. Tisley and Spiller, and Professor Dewar showed that it is possible by means of them to measure an electromotive force equal to $\frac{1}{10000}$ of a Daniell's cell; forces capable of decomposing water must be measured by causing two currents to act against each other. The index bubble is brought to zero by uniting the mercury cups by a wire. The apparatus is very convenient, as it requires no preparation and is extremely simple in its action. He next showed an instrument arranged by Mr. Tisley for producing a current by the dropping of mercury from a small orifice into dilute sulphuric acid; if the vessels containing the mercury and the acid be connected by a wire a current is found to traverse it. He then exhibited a manometer suitable for measuring very slight variations of pressure, and he illustrated the use of it for proving Laplace's law that the internal pressure multiplied by the diameter of a soap bubble is constant. It consists of a U-tube one arm of which is about fifteen inches long and is bent horizontally and levelled with great care. If the shorter arm be connected with a tube on which a bubble has been blown and the diameter of the bubble be varied, the position of the extremity of the alcohol column will be found to vary in accordance with the above law.—*Nature*, xv, 210.

E. C. P.

13. *Entwickelung der theoretischen Ansichten über die gepaarten Schwefelverbindungen;* von Geo. A. Smyth (of Amherst Mass.). 122 pp. 8vo. Berlin, 1876.—In the above titled Monograph the author has endeavored to give a critical, historical sketch of the theoretical views concerning the large and important family of organic-inorganic bodies, which may be appropriately designated as the *conjugated* or *copulated* compounds of sulphur, and which comprises the classes of *sulpho- sulphi-* and *hyposulphi-* acids, the *sulphohydrates* or *mercaptanes*, and their derivatives. Beginning with the discovery of the first organic derivatives of H_2SO_4 through the experiments of Dabit, Sertürner, Vogel, Gay-Lussac, Hennell and Faraday, and the formation of the first sulpho-compounds by Faraday and others, in the early part of this century, it discusses in successive chapters the older modes of viewing these bodies by Faraday, Magnus, Liebig, Regnault, Berzelius, Mitscherlich, and Fehling, the views of the originators of the theory of substitution, those of the followers of the electro-chemical

radical theory up to the time of Kolbe's modification of this theory, and the hypothesis of copulation, the further development by disciples of the radical theory in accordance with the *atomistic* conception of combination, the typical theory and the copulated compounds, the development of atomistic views of combination by the typicists, and the present modes of interpreting the copulated compounds. At the close a chapter is added describing briefly the discovery and the character of the different classes of the conjugated sulphur compounds, and more especially those of the sulpho-acids, their formation out of different groups of organic bodies, the number of sulpho-substitutions, their modes of formation, their metamorphoses through modifications of the inorganic group, and their decompositions by separation of the organic from the inorganic compound parts. In connection with this chapter some points of theoretic interest, such as the constitution of sulphurous acid, Kolbe's prognosis of sulpho-alcohols and aldehydes, etc., which could not be conveniently discussed in the main body of the work, are taken up.

After discussing the older modes of interpreting the sulpho-compounds, which were, from the insufficient data, necessarily crude, and which failed to give any systematic explanation of the action of H_2SO_4 upon organic bodies, the compounds being variously regarded as combinations of organic bases with sulphuric, hypo-sulphuric acid, etc., and after briefly sketching the rise of the theory of copulation, which was largely owing to the study of sulpho-acids, the author next treats of the development of the atomistic conception of combination by Kolbe and Frankland in the sixth decade, maintaining that we find here the first satisfactory explanation of the constitution of the copulated sulphur compounds, and the first conception of the sexivalence and consequently variable atomicity of sulphur. The reasons for Kolbe's explanation of the constitution of these bodies, as compounds of sexivalent sulphur having exerted so little influence, and of his claims to having established the hexavalence of sulphur, and also the quadrivalence of carbon having been so generally overlooked are sought for principally in his retention of equivalent formulæ, which could not express his own views of chemical combination, and which showed that his conception of atomicity, though broadly stated, was not defined with sufficient sharpness and definiteness.

Under the head of the typical theory in its relations to the copulated sulphur compounds, which is the subject next treated, the attention of the reader is directed to the influence of Gerhardt's discoveries of the sulpho-chlorides and amides, and Buckton's and Hofmann's preparation of numerous disulpho-acids, Gerhardt's comparison of the sulpho-compounds with the carbonic acid series as compounds containing the radicals SO_2 and CO respectively, Limpricht's and von Uslar's investigations of the sulpho-benzoic acid compounds, their view of the substitution of H in the organic radical by SO_2, Mendius' view of the typical formulæ as an ex-

pression of the constitution of chemical compounds, Kekule's mixed types, and the controversy between the champions of the typical theory, being the subjects most prominently taken up. The typical theory contributed, according to the view of the author, very little toward the advancement of our theoretic knowledge of the copulated sulphur compounds. It failed signally to throw light upon the peculiar nature of the sulpho-acids, it proved itself to be utterly unable, as the interpretations of Carius's investigations abundantly show, to explain any difference of constitution between the sulpho-acids and the metameric hypothetical primary ethers of sulphurous acid, while the adoption of complex multiple and mixed types showed the fruitlessness of all attempts to refer compounds capable of undergoing manifold reactions to any typical bodies. But an atomistic explanation of the copulated sulphur compounds presented peculiar difficulties to the disciples of the typical school, as it necessitated the acceptance of a higher atomicity of the sulphur atom, and accordingly it was not until the discovery of the true primary ethers of sulphurous acid, and of the isomeric phenole sulpho-acids, and furthermore of the difference in constitution of these acids from the primary acid ethers, that the typicists adopted an atomistic conception of combination.

After sketching the gradual development of atomistic and structural views by the former typicists, as shown most prominently in the attempts of Kekule to derive the copulated sulphur compounds from a dyad S, and in the adoption by Butlerow and Erlenmeyer of a higher atomicity for S, the author goes on to compare the views held at present with those advanced by Kolbe, endeavoring to show that the explanations of the chemical deportment of the sulpho-compounds now given are essentially the same as those given by Kolbe, some twenty years ago, that these chemists differ however from Kolbe in their general conception of the constitution of a body, and in their views as to the manner in which the S-atom is combined with the organic radical. The latter difference of opinion is, according to the author, the only essential one, and he, although assenting to Kolbe's general views as to the chemical constitution of a body, does not hesitate to accept Butlerow's definition of the sulpho-compounds, i. e. as compounds of a sexivalent S, in which the S is combined directly with a C-atom of the organic body.

II. Geology and Mineralogy.

1. *Note on the Age of the Crystalline Rocks of Wisconsin;* by Roland Irving. (Communicated.)—In a note on the "Huronian of Canada," published in this journal for December last, Mr. A. R. C. Selwyn, criticising Mr. F. H. Bradley's reference of the Canada, Wisconsin, and Michigan Huronian to the Lower Silurian, uses the words: "If, however, it is an established fact that in Minnesota (Michigan?) and Wisconsin the same Huronian rocks are unconformably covered by the Potsdam sandstone . . . ." Such

an unconformability in Wisconsin is certainly a fact, established not by one or two instances, but by many. The exact junction between the two formations is often to be seen, the almost loose sand of the Potsdam, with numerous fossils, as also fragments derived from the older rocks, lying upon and wedged in between the tilted ledges of Huronian quartzite, schist, or other rock. Exactly similar unconformability is to be seen at the Dalles of the St. Croix River between the Potsdam and Copper series; the horizontal beds of the former, filled with shells of *Lingulella*, lying directly upon the columnar melaphyre (?) of the latter series, the exact junction of the two series being exposed. The crystalline rocks of Wisconsin include unquestionably two distinct terranes, the one lying unconformably upon the other, as is beautifully shown at Penokee Gap, on Bad river, in the Lake Superior country. Here a white siliceous marble of the Huronian, overlaid by hundreds of feet of distinctly bedded slaty rocks, and dipping northward, is to be seen within twenty feet of large ledges of dark colored amphibolic gneiss, whose bedding planes dip southward and strike in a direction diagonally across that of the more northern beds. There are no doubt instances where the two series are difficult to separate, similar rocks occuring in both groups, but the existence of the two is incontestable, and their unconformability with the unaltered Potsdam equally so. The facts *proven* thus far with regard to the older rock series of Wisconsin may be briefly summarized as follows: the oldest (I) are gneisses and granites with other rocks; these are overlaid unconformably by (II) a series of quartzites, schists, diorites, etc., with some gneiss and granite; these in turn are overlaid—probably also unconformably, but this is not certainly proven—by (III) the Copper series, which includes greenstones and melaphyres, and also great thicknesses of interstratified sandstone, melaphyres, amygdaloids and shales, the whole having a thickness of several miles; these finally are unconformably covered by (IV) a series of unaltered horizontal sandstones including numerous fossils, many of which are closely allied to those of the Potsdam sandstone of New York, and all of which have a marked Primordial aspect. I and II are referred to the Laurentian and Huronian systems of Canada, because they bear the same relations to one another and to the Copper series that these systems do. However this may be, it will be seen that in order to include the Wisconsin crystalline rocks within the Silurian, Mr. Bradley would have to stretch that term so as to cover three entirely distinct terranes, each overlying its predecessor unconformably and many thousand feet in thickness, the highest of the three in its turn overlaid unconformably by horizontal sandstone with Primordial fossils. As to any of the Wisconsin or Michigan crystalline rocks being altered equivalents of the Primordial and newer strata of the eastern States, such an hypothesis is certainly untenable for a moment. Such things may and in all probability do occur in the Appalachians, but there

certainly has been no period of metamorphism in the region of the northwestern States since the beginning of the Primordial.

University of Wisconsin, March 8th, 1877.

2. *Microscopical Petrography;* by FERDINAND ZIRKEL. Being Volume VI of the series of Reports of the U. S. Geological Exploration of the 40th Parallel, CLARENCE KING, Geologist-in-charge. Submitted to the Chief of Engineers, and published by order of the Secretary of War under authority of Congress. 298 pp. 4to, with twelve plates. Washington, 1876.—The great region west of the Front Range of the Rocky Mountains, including the part in the vicinity of the 40th Parallel, abounds in igneous rocks, from dolerytes to trachytes and related kinds, some of them closely like rocks of central and southeastern Europe; and Mr. King has done well in looking to Europe for the study and description of his specimens, and has been most fortunate in securing the labors of Prof. Zirkel, the leading author in microscopic lithology. The results are therefore excellent, and at the same time they give to the American student the present European use of the names of rocks.

The Report commences with an Introduction reviewing the kinds of crystalline rocks and their microscopic distinctions. In this chapter Prof. Zirkel states that in his descriptions he uses the term "ground-mass" for the mass of a rock where it is distinctly crystalline granular under the microscope, and "base" when there is an amorphous paste not crystalline granular under the highest magnifying power, though containing, except in many obsidians, crystalline minerals.

He remarks also on the evidence that the crystalline minerals in the "base" were formed while the latter still had a flowing movement, as shown by the minerals ranging in straight or wavy lines, and by their fractures and abrupt bends or displacements; hence the positions and forms of the crystals have been partly determined by the flowing; and hence, also, the rock has not undergone any metamorphic changes since solidification took place. Those rocks whose micro-fluidal structure is particularly distinct are generally proportionally rich in broken crystals shivered into detached sharply angular fragments.

The feldspar-bearing igneous rocks he divides as follows:

I. The FELDSPAR ORTHOCLASE.—(*a.*) *Containing quartz or an excess of silica:* granite, granite-porphyry, felsite-porphyry, rhyolyte, obsidian, pearlyte, pumice, pitchstone.—(*b.*) *Containing no quartz, and often with more or less plagioclase feldspar:* syenyte, augite-syenyte, quartzless orthoclase-porphyry, trachyte, augite-trachyte.—(*c.*) *Containing no quartz, and with more or less nephelite or leucite:* Foyayte, miascyte, orthoclase-porphyry, phonolyte (containing nephelite), and leucite and sanidin rocks.

II. The FELDSPAR OF THE PLAGIOCLASE OR TRICLINIC SERIES.—(*a.*) *Containing hornblende:* quartz-dioryte, dioryte, porphyryte, hornblende-porphyry, propylyte, quartz-propylyte, hornblende-andesyte, and dacyte.—(*b.*) *Containing biotite:* mica-dioryte.—(*c.*)

Containing augite: diabase, augite-porphyry, melaphyre, augite-andesyte, feldspar-basalt (including doleryte and anamesyte), and tachylyte.—(*d.*) *Containing diallage:* gabbro.—(*e.*) *Containing hypersthene:* hypersthenyte.—(*f.*) *Containing olivine:* (serpentine) "forellenstein."

III. Containing NEPHELITE as the feldspar mineral.—Nephelinyte and nepheline-basalt.

IV. Containing LEUCITE as the feldspar mineral.—Sanidin-leucite rocks and leucite-basalt.*

To understand this list it is necessary to have in mind some points in German usage connected with the naming of rocks. First, as to the affix, *porphyry.* It is not, as might be inferred, the name of a natural group or family of rocks, but, as the list shows, it is applied to rocks of various groups. It signifies really a *porphyritic variety* of some kind of rock. Felsite-porphyry is a porphyritic felsite (typical porphyry); granite-porphyry is a porphyritic granite, though restricted by Zirkel to a kind in which the granite is of very fine grain, between ordinary granite and felsite. So in cases, not above particularized, diabase-porphyry is a porphyritic diabase, dioryte-porphyry, a porphyritic dioryte, and so on. Again, the affix is used where the disseminated crystals are not feldspar, but some other mineral: thus, hornblende-porphyry, as used by Zirkel, is a gray hornblendic rock in which the large disseminated crystals are hornblende; and augite-porphyry, one in which the crystals are augite. The science would be better off without the word, except as used in the adjective form.

Further: syenite of the Germans is a rock consisting of hornblende and orthoclase *without* quartz, unlike the rock of Syene, Egypt, which originated the name. Syenite containing quartz as a prominent constituent is made a variety of granite—although having its nearest relations to other hornblendic rocks; and, if not made the typical syenite, entitled, by usage elsewhere in the above list, to the name *quartz-syenite.*

Again, the names of some kinds of rocks are made to depend on their geological age—an igneous rock if of Tertiary age having one name, and if older than Tertiary, another. Thus, labradorite and augite along with more or less magnetite make together a rock which is called *basalt* or *doleryte* if Tertiary or younger, and *diabase* if of earlier date. It is a method of naming which might multiply names indefinitely, and which has nothing to commend it. It is to be noted also that Zirkel uses the name basalt in place of doleryte. Both basalt and diabase are described as often containing *viridite* or a hydrous chloritic mineral. The term melaphyre is restricted to an amygdaloidal basalt—an application not always easily made, since the same dike or mass of rock is often amygdaloidal in one small part and not through the rest of the mass, and there is an indefinite gradation between such melaphyre and the chloritic basalt. Peridotyte, or basalt containing olivine, is left as a variety of basalt.

* The *y*, in the last syllable of the names of many of the rocks, is inserted by the writer.

Of the above mentioned rocks, those found in western America include, under I, granite and granite-porphyry, felsite-porphyry, syenite; under II, dioryte, hornblende-porphyry, propylyte, quartz-propylyte, hornblende-andesyte, dacyte, trachyte, rhyolyte, diabase, melaphyre, gabbro, augite-andesyte, basalt; under IV, leucite rock.

The volume is chiefly devoted to the description of these rocks from different localities, after a study of microscopic sections, and comparisons with similar rocks of other countries; and numerous very singular and interesting facts are brought out, besides important illustrations of the relations and mode of origin of the rocks. We add some notes respecting them, following the order in this list.

Propylyte is the most prominent rock of the Washoe district, Nevada, constituting the entire Virginia range. It is a grayish-green rock, consisting mostly of a plagioclase or triclinic feldspar, in small crystals or grains, and hornblende, the latter disseminated in minute points or crystals through the former, and often in part changed to chlorite or epidote. Apatite is sometimes present, and occasionally biotite. In mineral constitution it is scarcely distinct from dioryte, the silica, according to the analyses given, amounting to 64 to 66 per cent. It is of Tertiary age, and hence it is not called dioryte; but, in addition, it has generally more of the aspect of a modern igneous rock. A quartziferous variety is the *quartz-propylyte*.

Andesyte has, according to Zirkel, the constitution essentially of propylyte, that is, it consists mainly of a plagioclase feldspar and hornblende; and the physical differences drawn out on page 133—such as a purer gray color, the hornblende in coarser crystallizations, etc.—are feeble in kind and degree. The analyses, however, give it about 60 or 61 per cent of silica, and this would make the feldspar of the rock to contain four to five per cent less of silica. Andesyte, moreover, has sometimes a pasty or semi-glassy groundmass. It occurs with the propylyte at various localities.

Dacyte is a *quartz-andesyte*, and this variety also occurs at Washoe and elsewhere. The color varies from light gray to dark blackish-brown. The ground-mass is often rhyolitic and sometimes spherulitic, and thus differs from that of andesyte and propylyte. The analyses show that the feldspar contains relatively little lime, and therefore must be, in the main, andesyte or oligoclase. The quartz, unlike that of quartz-propylyte, shows no fluid-inclusions when microscopically examined.

Trachyte is described as occurring in the vicinity of Washoe, and between there and Pyramid Lake. The rock consists of sanidin or glassy orthoclase, but part of it—the older—contains a plagioclase feldspar also, and thus graduates toward andesyte. Tridymite was observed in the younger trachyte in thin 6-sided plates grouped together in great numbers. A "half-glassy-looking rock" from the Cow Hills, between Sheep Corral Cañon and Wadsworth, of dark brownish-black color, containing sanidin, and also pale green augite with some plagioclase feldspar and horn-

blende, is called an *augite-trachyte.* It resembles in general composition the augite-syenyte of vom Rath, which constitutes the larger part of Mt. Monzoni in the South Tyrol. Other localities are mentioned of trachyte and of this augite-trachyte.

Rhyolyte was so named by Richthofen in 1860. It was made to include certain trachyte-like or felsitic and more or less glassy rocks which contained disseminated quartz, and bore "clearer evidence than other rocks of having once flowed in a viscous state." The more or less glassy kinds comprise obsidian, pearlstone, and pumice. These Zirkel designates *glassy rhyolyte.* Other kinds, felsitic and sometimes porphyritic, not appearing glassy, but showing a fluidal structure in having the ingredients arranged in parallel wavy bands, instead of even-grained, as seen in microscopic sections, he designates *proper rhyolyte;* and certain granite-like kinds (not observed among the rocks of the 40th parallel) he calls *nevadyte.* Rhyolyte is found at several places in Nevada, and many varieties are particularly described and figured. They sometimes contain disseminated quartz crystals or grains as large as peas. In some the structure is fine granular throughout; in others, there are glassy lines or patches; in others, spherulites; and some are glassy throughout.

Augite-andesyte contains over 58 per cent of silica—in this differing from most igneous augitic or pyroxene rocks. A variety from west of Basalt Creek, Washoe, is brownish-black, somewhat resinous in luster, with "white feldspar crystals which are seldom tabular," and contains hyalite in its amygdaloidal cavities and fissures. The base is partly glassy. The feldspar is partly orthoclase (sanidin) in twins, and partly a triclinic species, the latter predominating. The percentage of silica was found to be 58·015. The same rock has been observed on Teneriffe, Java, Chimborazo, in Hungary, etc. Augite-andesyte is near the melaphyre of some lithologists, but differs in the base being partly glassy. It shows its relation to basalt by containing some chrysolite. The rock also occurs red, blackish, and of other colors.

Basalt is described from various localities. In a variety from Kawsoh Mountains, having a structure "intermediate between the micro-porphyritic and the even-grained," microscopic aggregations of tridymite crystals were observed, in the form of thin hexagonal plates, partly overlapping like tiles and partly in groups. This is the first time tridymite has been met with in basalt; and it is remarked that "since the basalt comes to the surface through or near strata of infusorial silica, it is not impossible, as Mr. Clarence King has suggested, that an included fragment of this silica may be the source of the tridymite, in which case it would of course be a substance originally foreign to basalt."

Leucite rocks are described from the Leucite Hills, northwest of Point of Rocks, Wyoming Territory. They are light yellowish-gray felsite-like rocks, very rich in leucite crystals, and containing augite in grains yet sparingly, with no feldspar of any kind. They thus differ widely from the European leucite rocks.

We here leave the volume. It is a rich treasury of facts respecting American and other igneous rocks, and merits thorough study in every part by those who would fully understand their nature and relation. J. D. D.

3. *Note upon the Connecticut Valley Helderberg;* by C. H. HITCHCOCK. (Communicated.)—At the close of an article upon Helderberg rocks in New Hampshire (this Journ., III, vol. vii, p. 571), I proposed to discuss later the relations of the Bernardston, Mass., Helderberg limestone to the associated rocks in Hinsdale, N. H., and Vernon, Vt. This has been done fully in the second volume of the Geology of New Hampshire, which will be accessible to the public next June. I desire now very briefly to state my principal conclusions. 1. The associated quartzite and staurolite mica slates have been satisfactorily traced out to connect with the Coös group of New Hampshire, as was first suggested by Prof. Dana (this Journ., III, vol. vi, p. 339). 2. The limestone does not certainly dip beneath the quartzite. Had the section been drawn a few rods north the slates would be found to dip west and the quartzite standing on edge and the limestone concealed by soil. On the west side of the limestone is a west dip in the quartzite. These facts suggest the possibility of a different interpretation from that heretofore universally given. The limestone may be a remnant of a once extensive deposit covering both the other formations mentioned, and what remains is in an inverted position. The limestone in Littleton overlies the quartzite. 3. If the Coös and Helderberg strata are identical in age, the hornblende schist near by and the gneiss of Vernon are not necessarily associated with them, nor any of the great gneissic areas of New England. The Coös slates unconformably overlie the clay slates (Lower Silurian or Cambrian) of West Mountain and its continuation northward, as first suggested by Prof. Dana. These same slates rest upon the Quebec group of Logan in the Littleton region, and these in their turn upon the same gneissic group as in Vernon. 4. Next to the Helderberg the Coös rocks are the newest in the Connecticut valley all the way to Canada; and if they can be proved identical with each other, and also to include the enormous calcareous area of Eastern Vermont and Canada, called "Calciferous mica-schist" in the Vermont Report, they show that all the rest of the northern New England formations are older, and hence liable to be of any Eozoic series. 5. The Bernardston region abounds with examples of inversions of the strata. It is impossible to propound any consistent theory of structure here without them. The same is true for the whole of New Hampshire. 6. Further search in the Littleton region enables me to correct the statement of my previous article. I am satisfied that all the clay slates of Littleton are of the same age with those of West Mountain; hence at least three-fourths of the area marked Helderberg on my map (p. 471), must be transferred to the other series. 7. The kinds and order of the Helderberg rocks are essentially alike in the Littleton and Bernardston fields; hence, by comparing the facts in both regions better

results are obtained than by reliance upon short sections in either one by itself.

Hanover, N. H., March 16, 1877.

4. *On Geological Time;* by T. MELLARD READE. Presidential Address before the Liverpool Geological Society. 28 pp. 8vo. Liverpool, 1877.—In this paper, Mr. Reade has used the analyses of river waters to determine the amount of mineral matter carried in solution from the land. He finds that the amount of water run off the area of England and Wales annually is 68,450,936,960 tons, equal to 18·3 inches in depth out of 31·988 inches of mean rainfall, leaving 13·7 inches for evaporation. The amount of solids in solution is 8,370,630 tons, or 12·23 parts in every 100,000 of water:—in which are about 9·50 parts of carbonate and sulphate of lime and magnesia, 1·66 of chloride of sodium, 0·08 of nitrates and 0·99 of alkaline sulphates and carbonate of soda, silica and sesquioxide of iron. Estimating the solids in solution at 15 cubic feet to the ton, the amount of denudation by solution would be ·0077 feet per century, or one foot in 12,978 years. Prestwich arrived at one foot in 13,200 years, for the amount of carbonate of lime which the Thames carries off from the Chalk, Upper Greensand, Oolitic strata and Marlstone. The Thames, estimating the discharge at 8 in. per annum, and the total solids at 29·26, as given by Prestwich, removes 147 tons per square mile per annum; and the denudation over England 143·5 tons.

Mr. Reade makes similar calculations for the rivers of Europe, and finds that the Rhine removes about 92·3 tons per square mile; the Rhone about 232 tons; the Danube about 72·7 tons; giving an average for the three rivers of 90 tons per square mile. The Garonne removes 142 tons per square mile; the Seine about 97 tons. From these data the conclusion is reached that probably over the world about 100 tons of rocky matter are dissolved by rain per English square mile per annum: of which, as near as can now be estimated, 50 tons may be carbonate of lime, 20 tons sulphate of lime, 7 silica, 4 each carbonate and sulphate of magnesia, chloride of sodium, and 6 alkaline carbonates and sulphates.

The amount of detritus brought down annually by the Danube is about $\frac{1}{3000}$ of the water, or three times the calculated amount of solids in solution; that of the Mississippi, according to Humphreys and Abbott, $\frac{1}{1321}$ of the water. Mr. Reade adds:

"If we were to take the solids removed mechanically at six times those in solution, which is a very high estimate, we should have over the whole of the globe 600 tons of denuded matter annually per square mile. Taking the sedimentary crust of the earth at ten miles thick throughout—a moderate estimate—and allowing for the denudation of the sea and the amount added to sediments by volcanic ejections, matter equal to one-third that which is denuded from the land, we should have annually removed and deposited matter equal to 800 tons per square mile of land surface, or 40,800 million tons annually. The total surface of the globe is 197 millions of English square miles. A cubic mile of

rock at 13½ feet to the ton would weigh 10,903,552,000 tons, so that to cover the whole surface of the globe one mile deep with sediment from the land at the rate of 800 tons per square mile of land surface, would take 52,647,052 years, or 526 million years in round numbers for ten miles deep."

5. *The Carboniferous and Permian a continuous formation in Bohemia.*—A paper full of details as to fossils is published by Dr. Feistmantel in the Geological Magazine for March, in which the author proves that "in Bohemia (certainly also in other localities) there is no strict boundary between the Carboniferous and Permian; on the contrary, that these formations are in very close connection, as is shown in the association of a flora of Carboniferous character with animals mostly of Permian character, in the Gas-coals of the Pilsen and Kladno-Rakonitz basins." In the Pilsen coal-basin the gas-coal contains the Permian animal fossils, *Xenacanthus Decheni*, "one of the best Permian species," an *Acanthodes* near *A. gracilis* Röm., a *Palæoniscus*, *Uronectes* (*Gampsonyx*) and other species; and there are among fossil plants, *Lepidodendron dichotomum* Stbg., *Sagenaria elegans* Stbg., *Knorria*, *Lepidophyllum majus* Brgnt., *Sigillaria distans* Stbg., species of *Cyclopteris*, *Odontopteris*, *Neuropteris*, about nine Carboniferous species of *Sphenopteris*, four Carboniferous species of *Cyatheites*, three of *Alethopteris*, etc. Similar facts are reported from the other district referred to.

6. *Revue de Géologie pour les Années* 1874–1875, Vol. XIII; by M. Delesse, Ingenieur-en-Chef des Mines, et M. de Lapparent, Ingenieur des Mines, Prof. Geol. 252 pp. 8vo, with a colored agricultural chart of France showing its agricultural products, by M. Delesse. 1877.—From this valuable Geological Annual, bringing up the review of geological memoirs and discoveries to the middle of 1875, we cite the following:

Feldspathic rocks under the solvent action of water, carbonated waters and other reagents in solution.—M. Truchot subjected a series of Auvergne rocks in powder for several days to water charged with carbonic acid under a pressure of eight atmospheres, and obtained the following percentage results:

	Whole am't dissolved.	CaO removed.	K_2O removed.	P_2O_5 removed.
Granite of Montaigui	0·80	---	0·10	---
Granite of Trezioux	0·90	---	0·09	---
Lava of Volvic	1·75	0·25	0·08	trace
Domite, Puy de Dome	1·82	tr.	0·06	tr.
Trachyte of Mt. Dore	2·90	tr.	0·18	tr.

The trachyte was most readily attacked, especially its silica, and this accounts for the frequent occurrence of opal and other siliceous deposits in the fissures of this rock.

M. Cona, exposing the syenite of Bielle, finely pulverized, to water, dissolved 0·18 per cent at the ordinary temperature, and 0·42 at 100° C.; to water saturated with CO_2, dissolved 0·63 per cent; to water saturated with sulphate of lime, 0·43 per cent.

Orthoclase feldspar has been exposed to different solutions by A. Beyer, aided by Birner, Ulbricht and Heinrich (Arch. Pharm. II, cl, 193). A kilogram finely pulverized was put each time in two liters and a half of water or certain solutions, and kept so for about five months—out of contact with the air. The weight in grams dissolved in the 2½ liters of water for the different liquids was as follows:

	Equiv.	K_2O	Na_2O	CaO	MgO	Fe, Al	SiO_2
Distilled water	--	0·051	0·078	0·058	0·006	----	0·049
Carbonic acid in water	--	0·071	0·114	0·076	0·004	0·009	0·069
Lime	0·1	0·209	0·174	0·067	0·003	0·008	0·061
Magnesia	1·0	0·359	0·315	0·013	0·004	----	0·159
Magnesia and CO_2	1·0	0·312	0·255	tr.	0·569	---	0·048
Gypsum	0·2	0·053	0·074	1·906	0·016	----	0·033
Sulphate of ammonium	0·2	0·161	0·094	0·122	0·035	----	0·066
Chloride of sodium	0·2	0·163	----	0·091	0·008	0·004	0·032

The results are of much interest, showing that common salt and sulphate of ammonium, products that are usually in the soil, increase much the dissolving power of water; and still more do lime and magnesia—these bases separating the alkalies. Lemberg has shown that by the action of sulphate of magnesia on the zeolites, operating in closed tubes with heat, they were changed to hydrous silicates of magnesia; apophyllite being thus changed, losing in the process all but a few hundredths of its lime. Such facts are of great interest in connection with the subject of the origin of serpentine pseudomorphs.

7. *A fossil Saurian Vertebra from the Arctic Regions.*—Prof. A. Leith Adams has named the Saurian, a vertebra of which was brought from Rendezvous Point, Byam Martin Channel, by Admiral Sherard Osborn, *Arctosaurus Osborni*. It is "in all probability one of the middle cervicals of a Saurian with biconcave vertebræ," between ten and twelve feet long, agreeing "better with Lacertilia than Crocodilia." Sir Edward Belcher, Sir L. McClintoc, and Admiral Osborn brought many fossils from the group of islands lying between North Cornwall and North Devon. Among others were remains of Ichthyosaurus, determined by Prof. Owen, and said to be from Lias beds; and these are the only Arctic Reptilian remains hitherto described.

8. *Fossil Vertebrates from the Fort Union beds of Montana.*—Prof. E. D. Cope has described the following species in the Proceedings of the Philadelphia Academy of Natural Sciences, for 1876, p. 248: *Aublysodon lateralis*, *Lælaps incrassatus*, *L. explanatus*, *L. falculus*, *Dysganus encaustus* (a herbivorous Dinosaur), *D. Haydenianus*, *D. bicarinatus*, *D. peiganus*, *Diclonius pentagonus* (allied to *Hadrosaurus*), *D. perangulatus*, *D. calmarius*, *Monoclonius crassus* (near *Hadrosaurus*), *Paronychodon lacustris* (near *Plesiosaurus*), all based on specimens of teeth; also *Compsemys imbricarius*, *C. variolosus*, *Polythorax Missuriensis*, *Hedronchus Sternbergii*, *Ceratodus cruciferus*, *C. hieroglyphus*, *Myledaphus bipartitus*.

9. *A Text-book of Mineralogy, with an extended Treatise on Crystallography and Physical Mineralogy;* by EDWARD SALISBURY DANA, Curator in Mineralogy, Yale College. On the plan and with the coöperation of Prof. JAMES D. DANA. 486 pp. large 8vo, with over 800 wood-cuts and a colored plate. New York, 1877. (John Wiley & Sons, 15 Astor Place).—This work is intended for a class-book in the science. One half is occupied with the subjects of Crystallography, Physical Mineralogy, and Chemical and Determinative Mineralogy, and the other half with the Descriptions of species and a Catalogue of American localities. The subjects of crystallography and optical mineralogy are treated at much length in order that the student may have at hand the means of acquiring the special knowledge demanded for complete investigations; and illustrations and descriptions of the best instruments are given for the same purpose, besides numerous diagrams and figures of crystals. About seventy pages are devoted to descriptive crystallography, over twenty to mathematical crystallography after Nauman's system, and as many more to the same after Miller's system, each of which subjects is very fully illustrated by figures; and the chapter on optical characters extends to thirty-five pages. Besides, there are lists of recent works and memoirs on the various subjects considered under Physical Mineralogy.

The Descriptive part of the volume follows in its classification essentially that of the last edition of the system of Mineralogy, and is, in the main, a condensation of that work. But all new species introduced since the date of its publication have been inserted. The more important species—about half of all known—are described at length (though with few analyses, and often only the percentage composition), and the rest more briefly.

The preparation of this text-book, as the Preface states, was begun by Professor Dana shortly after the appearance of his larger work. But it was interrupted before the crystallographic part was completed; and in that state it has remained until taken up within the year past by Mr. Edward S. Dana. To Mr. Dana is due a revision of the crystallographic chapter, with some important modifications, the chapter on Miller's System, the section on Optical mineralogy, the notes on all new species, and a general review of the whole subject, bringing in results from recent publications.

For the full synonymy of the mineral species and the history of that synonymy, extended descriptions of American and foreign localities, tables of the many chemical analyses of minerals that have been made from the earliest times, notes on the alterations of minerals and occurring pseudomorphs, and some other points the reader will still have to look to the System of Mineralogy and its Supplements.

10. *Second Preliminary Report on the Mineralogy of Pennsylvania*, by F. A. GENTH; with analyses of mineral-spring waters. Harrisburg, 1876.—This is a report of progress, embodying the

work done upon the mineralogy of Pennsylvania during the year 1875. It contains a considerable number of new analyses, mostly of minerals, also of rocks, mineral waters and natural gases. Among other points Dr. Genth shows that the "*melanosiderite*" of Cooke is "not a good species, but simply an impure variety of hydrated iron sesquioxide, probably limonite." The "*cassinite*" from Blue Hill, Delaware Co., described by Lea as a variety of orthoclase, is shown to contain 3·7 p. c. baryta; the mean of three analyses gave: Silica 62·60, alumina 19·97, iron sesquioxide 0·12, magnesia 0·02, lime 0·19, strontia, tr., baryta 3·71, soda 4·43, potash 9·00, ignition 0·19=100·23. Specific gravity 2·692. E. S. D.

11. *Brief Notices of some newly described minerals. Ludlamite.*—Occurs in small monoclinic crystals, with distinct basal cleavage. Hardness 3·4. Specific gravity 3·12. Color clear green; transparent. Its composition is expressed by the formula $2Fe_3P_2O_8+H_2FeO_2+8aq$, which requires: Phosphorus pentoxide 29·88, iron protoxide 53·06, water 17·06=100. The formula of vivianite, to which it is related, is $Fe_3P_2O_8+8aq$. Ludlamite occurs in some of the mines of Cornwall, England, associated with vivianite, siderite, pyrite, arsenopyrite, etc.—(*Field, Phil. Mag.*, Jan., 1877.)

Strengite.—Occurs usually in spherical incrustations with a radiated structure, and a drusy surface; also rarely in orthorhombic crystals of tabular form. Hardness 3–4. Specific gravity 2·87. Color white, in some varieties bright carmine-red, in crystals also colorless. Transparent to translucent. Composition expressed by the formula FeP_2O_8+4aq, which requires: Phosphorus pentoxide 37·97, iron sesquioxide 42·78, water 19·25=100. In form and composition it is allied to scorodite ($FeAs_2O_8+4aq$). Strengite is found with cacoxenite at the iron mine Eleonore near Giessen.—(*Nies, Jahrb. Min.*, 1877, 8.)

Pelagite.—The name *pelagite* is given provisionally by Prof. A. H. Church to the material constituting the "manganese nodules" obtained by the Challenger in deep-sea soundings in the Pacific. An analysis afforded the following results: Manganese dioxide 30·22, iron sesquioxide 20·02, alumina 3·30, silica 10·37, chlorine 0·71, Mg, Ca, Na, etc., 0·83, water lost below 100° 24·55, lost at a red heat 10·00=100. It will be seen that the nodules, if homogeneous, have a complex chemical composition, and by no means consist essentially of "nearly pure peroxide of manganese," as had been reported. As stated by Prof. Church, the further analysis of additional material is needed before the name *pelagite* can be fairly accepted.—(*Church, Mineralogical Magazine*, No. 2, p. 50, Nov., 1876.)

Lawrencite.—M. Daubrée has given the name *lawrencite* to the protochloride of iron, the presence of which he has detected in the Greenland meteoric iron. It was earlier separated by Dr. J. Lawrence Smith from the Tennessee meteoric iron, and the name is given in honor of him.—(*C. R.*, Jan., 1877.)

Hydrocastorite.—G. Grattarola of Florence has observed a white mealy material surrounding the castorite of Elba, and he

makes it a new mineral under the name hydrocastorite, it having been derived from the decomposition of castorite. It is in part compact, in part it is made up of an aggregate of fine needle-like crystals. Its composition is shown by the analysis: Silica 59·59, alumina 21·35, lime 4·38, water 14·66=99·98.

Guanajuatite.—The sulpho-selenide of bismuth from Guanajuato, Mexico, partially described by Castillo, (1873), and later fully described by Frenzel (Jahrb. Min., 1874, 679), was named *frenzelite* in the Second Appendix to Dana's Mineralogy (1875, p. 22). It seems, however, that the same mineral was at first named *guanajuatite* by Fernandez, who described it in full in the Guanajuato paper, "La República" for July 13th, 1873. The latter name should consequently be accepted instead of the name *frenzelite*. The description by Professor Fernandez differs from that of others in that he makes the mineral solely a bismuth selenide (Bi_2Se_3), and attributes the presence of a small amount of sulphur, shown in his analyses, to the admixture with a little pyrite. The material analyzed by Frenzel received the formula $2Bi_2Se_3 + Bi_2S_3$.

Silaonite.—In the paper, "La República," for Dec. 23d, 1873, Professor Fernandez describes a second bismuth selenide from the same locality, the Santa Catarina mine at Guanajuato. It has a lead-gray color, and is compact in structure. Its hardness is a little less than that of calcite; its specific gravity 6·428–6·45. The results of several analyses upon material more or less pure led to the conclusion that the chemical composition is expressed by the formula Bi_3Se. E. S. D.

12. *Zeitschrift für Krystallographie und Mineralogie;* vol. i, No. 1, 1877.—The first number of this new Journal, recently received, admirably fulfills the promises made in the Prospectus. (See p. 162 of this volume.) It contains the following original articles: Mineralogical contributions by G. vom Rath; description of some immense enstatite crystals from Bamle, Norway, by W. C. Brögger and G. vom Rath; on the crystalline form of lanarkite, by A. Schrauf; on the regular grouping of quartz crystals on calcite, by E. S. Dana; on the dimorphism of hydrochinon and paranitro phenol, by O. Lehmann; a manganese variety of tremolite, by G. A. Koenig; on the form of crystals of barium sulphate, etc., by H. Baumhauer; on the schorlomite from the Kaiserstuhl, by A. Knop. In addition to the above articles, a series of notices and extracts, upwards of thirty in number, and covering as many pages, follow. These are derived from a great variety of sources, and form not the least valuable part of the number. Under the able editorship of Professor Groth, it cannot be doubted that the new Journal will always maintain the high character it has at its commencement. E. S. D.

13. *Ueber den inneren Zusammenhang der verschiedenen Krystallgestallten des Kalkspaths*, von Dr. F. Scharff; 61 pp. 4to, with five plates. Frankfort, 1876.—The memoirs previously published by Dr. Scharff upon the interior crystalline structure of several

mineral species, as quartz, feldspar, gypsum, have been most valuable contributions to the subject of Crystallogeny; and the same is eminently true of the present memoir upon Calcite. Dr. Scharff describes with great care and minuteness the results of his observations upon a large series of calcite crystals, and the descriptions are further elucidated by many excellent figures. His attention was especially directed to those cases in which the formation of the crystals was incomplete, or had been in some way interrupted, and from these sources he draws his conclusions as to the method of formation of the crystals, and the conditions determining their growth. E. S. D.

14. *Upon the Chemistry and Composition of the Porcelain and Porcelain-rocks of Japan;* by HENRY WURTZ.—Dr. Wurtz has published, in a recent number of the American Chemist, a paper of some length upon the porcelain-making of the Japanese, prepared by him in his capacity as Judge in one of the departments of the Centennial Exhibition. He gives a description of the occurrence of the materials in Japan, and the methods employed in the preparation of the porcelain from them. The chemical composition of both the natural materials in their different varieties and the manufactured products are also given at length in a series of analyses.

III. BOTANY AND ZOOLOGY.

1. *Dictionnaire de Botanique, par* M. H. BAILLON, Paris. (Hachette & Cie.)—We noticed the first fascicle at the time of its appearance. The second and third are now received, reaching to p. 240, and to the article *Apothecium;* so that about 300 pages will be devoted to the first letter of the alphabet. The work must needs be voluminous, for it is a veritable encyclopedia, and various articles have developed almost into treatises, with profuse and excellent wood-cut illustrations. The main articles of this sort in the present fascicles are *Albumen*, *Aleurone*, *Algæ*, *Aliments des plantes*, *Alternance des générations*, *Amidon* (starch), *Androcée* (which should be, as M. Littré says, *Andrœcie*, under which synonym only is the proper derivation given), *Anthère*, *Antheridie*, and *Antherozoides*. The work improves as it advances, and if in danger of being too bulky, it is certainly low-priced, considering execution, and fullness of illustration.

Under *Ainslicea*, by some mischance, it is said that to this imperfectly known genus, *Parthenice* Tor. & Gray probably belongs; and over the leaf there is something equally confounding under *Aiolotheca*. The explanation is that the last five lines of the two articles have been accidentally transposed in manuscript or type, and then one word altered in proof-reading. A. G.

2. *Flora Fossilis Arctica; Die Fossile Flora der Polarländer*, von Dr. OSWALD HEER, Vierter Band, mit 65 Tafeln, 4to, Zurich, J. Wurster & Comp. 1877.—This fourth volume of a classical, and to us particularly interesting work, is a collection of three memoirs.

First, Beiträge zur fossilen Flora Spitzbergens; with a geological appendix, by Prof. Nordenskiöld. This belongs to the fourteenth

volume of the memoirs of the Royal Swedish Academy of Sciences, Stockholm, no. 5, issued in 1876.

Second, Beiträge zur Jura-Flora Ost-Sibiriens und des Amurlandes, is from the memoirs of the Imperial Academy of Sciences, of St. Petersburg, vol. xxii, issued in 1876.

Third, A small part, with only two plates, Ueber die Planzen-Versteinerungen Von Andö in Norwegen, apparently has not elsewhere appeared.

This East Siberian Jurassic flora is rich in Gingkos (seven species), with some allied Taxineous genera, as well as some *Taxodieæ*, more *Abietineæ*, and three Monocotyledons (*Pandaneæ*). The Spitzbergen deposits referred to that era, furnish six or seven species or forms of Gingko, three Pines, and a sort of Bamboo; the Cretaceous, three or four Pines, Sequoias, a *Torreya*, etc.; and the Miocene has *Taxodium*, *Glyptostrobus*, *Sequoia*, *Cyperus*, *Carex*, *Maianthemum*, *Alisma*, seven Poplars, two Alders, three Hazels, a Hornbeam, a Beech, four Oaks, an Elm, a Plane-tree, an Ivy, five species of *Cornus*, two of *Nyssa*, and a *Nyssidium*, two of *Magnolia*, a *Parrottia*, a *Tilia*, three Maples, a *Kœlreutera*, three Hawthorns, and a veritable fossil strawberry! A. G.

3. *Proceedings and Transactions of the Nova Scotia Institute of Natural Science*, vol. iv, part 2, 1877.—This part is rather rich botanically. Professor Sommers institutes an elaborate comparison between the flora of Nova Scotia and that of Colorado. Rev. E. H. Ball, gives an interesting and readable account of the Ferns of Nova Scotia. Prof. Lawson, in notes upon some Nova Scotian plants, takes up the *Calluna vulgaris* question, enumerates the known stations in the provinces, and the circumstances and condition of most of them; and concludes that while one or two of them may be artificial, "it has been originally a native indigenous plant," and "that the various traditions as to the foreign origin of the heather, are not unlikely to have been suggested by the desire to account for the presence of what was regarded as necessarily a foreign plant, rather than by actual historical facts." There are several communications relating to *Rhododendron maximum*, which has its northern and eastern limit in Nova Scotia. Finally, Professor Sommers gives a catalogue of the plants of the Province. A. G.

4. *Lady Smith*, the widow of Sir James Edward Smith, and his survivor for almost half a century, died on the third of February last. She was born, May 11, 1773. An authenticated copy of the register of her baptism was printed in the London Times (which has been skeptical about centenarians) along with an interesting biographical notice. There is no room for doubt that, if she had survived three months longer, she would have been 104 years old. She not only lived long but enjoyed life to the last. She wrote a clear and firm hand, at least up to her hundredth year; her eyesight of late failed only so far that she was unable longer to read or guide her pen; "her hearing was at worst only a little hard," her teeth were almost perfect, and her memory was nearly unimpaired. Since Dr. Torrey's death, probably the only surviving

correspondent of her husband is Dr. Jacob Bigelow, who on the 27th of February attained the age of 90. A. G.

5. *Joseph de Notaris*, the distinguished Italian Bryologist, who was born on the 5th of May, 1805, and who was lately transferred from the chair of botany in the University of Genoa, to that at Rome, died on the 22d of January last. A. G.

6. *Recent Papers on Fungi.*—The following are articles of interest, which have recently appeared:

(1.) *Reproduction des Ascomycetes*, par M. MAX CORNU,—Annales des Sciences Naturelles, 6e Série. Tome iii.

(2.) *Beiträge zur Kenntniss der Pycniden* 1; von Dr. HERMANN BAUKE.—In the two papers by Cornu and Bauke, an attempt has been made to discover the nature of the organs known as *spermatia*, *stylospores*, and *pycnidia*. The two last named organs, since the publication of Tulasne's Carpologia, have been generally admitted to be secondary forms of species of Ascomycetes. Certain cases, however, seemed to point to the conclusion that some pycnidia were independent organisms, and it was to settle this point that Dr. Bauke made his investigations. His method consisted in the artificial cultivation of different spores, and resulted in a general confirmation of Tulasne's views. The observations of Cornu have extended over several years; and, in regard to the spermatia, he comes to the conclusion that they cannot be considered male organs. He has observed that they germinate, and thinks that they must be regarded as a form of stylospore. Although contrary to the view generally maintained as to the nature of spermatia, and to the views expressed by Stahl in the Bot. Zeitung, Mar. 20, 1874, Cornu's view coincides with what has recently been published in the Bot. Zeitung and Comptes Rendus with regard to the supposed spermatia of species of Coprinus by Brefeld and Von Tieghem. The reason why the germination of spermatia has not been seen until recently is explained by Cornu by the fact that most cultures of spermatia have been made with pure water, whereas the presence of some special nutritive fluid, as solution of gum, bark, etc., seems to be necessary. Cornu was led to this conclusion by noticing that, when sown on a glass slide, under a cover-glass, the spermatia germinated more readily on the side next the gummed label.

(3.) *Ueber den Gitterrost der Birnbäume und seine Bekämpfung;* von Dr. G. KRAMER; An interesting paper in the Schweizerische landwirthschaftliche Zeitschrift on a disease of pear trees, caused by *Ræstelia cancellata* Rebent, which Dr. Kramer agrees with Oersted in considering a form of *Podesoma fuscum* Duby occurring on *Juniperus sabina*, L. W. G. F.

7. *Destruction of Forest Trees by Mistletoe;* by E. S. CROZIER. (From letter to Editors dated Louisville, Ky., March 9, 1877.)—The American Mistletoe (*Phoradendron flavescens*) is very common in this latitude (38°), and bids fair to become an important factor in the forest culture of regions favorable to its growth. It grows luxuriantly upon the branches of the elm and black walnut; and it has increased to such an extent that large forests of the latter

are now almost destroyed. In many sections this valuable timber has entirely disappeared; and in others the branchless trunks, still standing, attest the destructive effects of this parasite. As soon as a bunch of mistletoe fixes itself upon a branch, the outward extremity ceases to grow, and finally dies. The tree soon presents a clubby appearance, followed by death. A grove of black walnuts, just east of this city, was notable a few years ago for its depth of foliage and the thrifty growth of its individuals. It is now a picture of desolation. A few years will witness its total destruction. The importance of this subject to the industrial interests of the country should commend it to the attention of those interested in arboriculture, in the hope that some means may be devised for preventing the ravages of this parasite.

8. *Median and Paired Fins, a Contribution to the history of Vertebrate Limbs;* by JAMES K. THACHER.—This memoir is from volume iii of the Transactions of the Connecticut Academy. It is the result of a careful comparison of the fins of various species of fishes at early stages of growth, and is illustrated by twelve plates. The view reached is in opposition to that of Gegenbaur on the subject, and is expressed thus:

As the dorsal and anal fins were specializations of the median folds of Amphioxus, so the paired fins were specializations of the two lateral folds which are supplementary to the median in completing the circuit of the body. These lateral folds, then, are the homologues of the Wolffian ridges, in embryos of higher forms. Here, as in the Median fins, there were formed chondroid and finally cartilaginous rods. These became at least twice segmented. The orad ones, with more or less concrescence proximally, were prolonged inwards. The cartilages spreading met in the middle line, and a later extension of the cartilages dorsad completed the limb girdle.

If now we seek to determine the form of limb for the Protognathostomi, that is to say, for that time for which the archipterygium in its entirety is proposed, we should propose this:

The limbs of the Protognathostomi consisted of a series of parallel articulated cartilaginous rays. They may have coalesced somewhat proximally and orad. In the ventral pair they had extended themselves mesiad until they had nearly or quite met and formed the hip girdle. They had not here extended themselves dorsal. In the pectoral limb the same state of things prevailed, but was carried a step further, namely, by the dorsal extension of the cartilage constituting the scapular portion, thus more nearly forming a ring or girdle.

IV. ASTRONOMY.

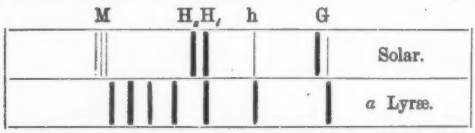
1. *Elements of Borelly's Comet;* by AARON N. SKINNER, Assistant U. S. Naval Observatory. (From a letter to the editors, dated Washington, D. C., March 13, 1877.)—I have deduced the following elements of Borelly's Comet from equatorial observations made at this Observatory, February 9, 12 and 17.

$$\left.\begin{aligned} T &= 1877, \text{ Jan. } 18{\cdot}9658, \text{ Wash. M. T.} \\ \pi &= 174^\circ\ 15'\ 32'' \\ \Omega &= 187\ \ 10\ \ 4 \\ i &= 152\ \ 20\ \ 28 \\ \log g &= 9{\cdot}90709 \end{aligned}\right\} \text{Apparent Equinox, Feb. } 13{\cdot}7.$$

The constants for computing the rectangular coördinates are:

$$x' = 9{\cdot}90639 \sin (250^\circ{\cdot}7068 + v) \sec {}^2\tfrac{1}{2}v$$
$$y' = 9{\cdot}71223 \sin (336^\circ{\cdot}7634 + v) \sec {}^2\tfrac{1}{2}v$$
$$z' = 9{\cdot}79456 \sin (343^\circ{\cdot}4010 + v) \sec {}^2\tfrac{1}{2}v$$

2. *Note on the Photographic Spectra of Stars;* by WILLIAM HUGGINS, D.C.L., LL.D., F.R.S. (From the Proceedings of the Royal Society, No. 176, 1876).—In the year 1863 Dr. Miller, and myself obtained the photograph of the spectrum of Sirius. "On the 27th January, 1863, and on the 3d of March of the same year, when the spectrum of this star (Sirius) was caused to fall upon a sensitive collodion surface, an intense spectrum of the more refrangible part was obtained. From want of accurate adjustment of the focus, or from the motion of the star not being exactly compensated by the clock movement, or from atmospheric tremor, the spectrum, though tolerably defined at the edges, presented no indications of lines. Our other investigations have hitherto prevented us from continuing these experiments further; but we have not abandoned our intention of pursuing them."* I have recently resumed these experiments by the aid of the 18-inch speculum belonging to the Royal Society's telescope in my possession. Considerable delay has arisen from the necessity, for these observations, of a more uniform motion of the driving-clock. For this purpose, Mr. Howard Grubb has successfully applied to the clock the control of a seconds pendulum in electric connection with a sidereal clock. This system works quite satisfactorily. The prisms employed are made of Iceland spar, and the lenses of quartz. After an extensive trial of different photographic processes, preference has been given to dry plates. The apparatus is so arranged that a solar or electric spectrum can be taken on the same plate, for the purpose of comparison, with the spectrum of the star. Spectra have been obtained of Sirius, Vega, Venus, the Moon, etc. I do not purpose in this preliminary notice to describe in detail the arrangements of the special apparatus which has been constructed, nor to offer the results of the experiments in



their present incomplete state to the Royal Society. Still I venture to hope that, even in this early stage of the inquiry, the enlarged copy of the spectrum of Vega (α Lyræ) which accompanies this note may not be regarded as altogether unworthy of

* Phil. Trans., 1864, p. 428.

attention. After exposure to the light of Vega, the dry plate was allowed to remain in the instrument until the following morning, when a solar spectrum was taken upon it, through the half of the slit which had remained closed when the instrument was directed to the star. The photograph shows seven strong lines, all of them slightly shaded at the sides. The two lines which are least refrangible coincide with two known lines of hydrogen in the solar spectrum. It is expected, by means of an apparatus now in the course of construction, to obtain also any finer lines which may be present in the spectrum of this star, as well as to extend the photographic method to stars which are less bright. I need not now refer to the many important questions in connection with which photographic observations of stars may be of value.

3. *Tables of the Satellites of Jupiter;* by D. P. Todd. 40 pp. 4to. —Published for the American Ephemeris by authority of the Secretary of the Navy. The tables of Damoiseau published in 1836 give the places of Jupiter's satellites up to the year 1880. The present tables are a continuation of Damoiseau's by the same formulæ and elements to the year 1900.

V. Miscellaneous Scientific Intelligence.

1. *Geological Society of London.*—At the Annual Meeting, February 16th, the Wollaston Gold Medal was presented by the President of the Society, to Mr. Robert Mallet, for his able researches on earthquakes, volcanoes, volcanic energy, and other important scientific labors; the Murchison Medal to Rev. W. B. Clarke, of Sydney, Australia, for his various geological discoveries during the half century past in New South Wales; the Lyell Medal and part of the Lyell Fund to James Hector, Director of the Geological Survey of New Zealand; the balance of the proceeds of the Lyell Fund, to Mr. Pengelly, for his explorations of Kent's Cavern.

At the same time the Bigsby Medal, founded last year by Dr. Bigsby, F.R.S., F.G.S., formerly an able worker in the geology and paleontology of British North America, was given to Prof. O. C. Marsh, of Yale College, "in recognition of the great services which Prof. Marsh has rendered to the paleontology of the Vertebrates;" whose studies include "fossil remains of nearly every great group of the Vertebrata from the Paleozoic, Cretaceous and Cenozoic strata of the New World," and "are so numerous and so important as to mark an epoch in this line of research."

2. *Bulletin of the Buffalo Society of Natural Sciences*, vol. III, No. 4. 1877.—This number of the bulletin contains a check-list of the fresh-water fishes of North America (concluded) by D. S. Jordan; the Shinumos, by F. S. Dellenbaugh; on the peopling of America, by A. R. Grote; on the Hyphomecetous Fungi, by M. C. Cooke. Mr. Grote's paper applies the idea respecting the migrations of species in consequence of the

approach and retreat of the cold and ice of the Glacial era (which has been illustrated by different authors with respect to plants and animals generally, and in Europe as regards man) to man in North America, but without any special facts in proof of the suggested migration.

3. *The California State Geological Society* "has been recently incorporated for the purpose of making a collection of mineral products of the Pacific coast," promoting the progress of economic Geology, and "encouraging the study of Geology in all its branches." The President of the Society is Mr. HENRY G. HANKS, and the Secretary S. HEYDENFELDT, Jr.

4. *Meteorology of Golden, Colorado*, in lat. 39° 44′ 24″ N., long. 28° 8′ 10″ W., 5,618 feet above the sea.—Mean temperature for 1876, 51·64° F.; precipitation 18·36 in.; mean temperature of the warmest day 80·7° F.; do. of the coldest day (March 10) 8° F. above zero; mean temperature of the winter months, 36·18° F.; spring, 45·90; summer, 69·90; autumn, 54·60; winds between N.E. and S.E. 20 to 30 days for the several seasons, and between W., S. and S.E. 20 to 30 days for the several seasons, and between N. and S.W., 57 to 72 days for the seasons.—*E. L. Berthoud, in Colorado Transcript* for Jan. 10.

5. *The American Microscopical Society of the City of New York.*—At the annual meeting held January 9th, the following officers were elected for the ensuing year: President, John B. Rich, M.D., 1 West 38th street, N. Y.; Vice-President, Wm. H. Atkinson, M.D., 41 East 9th street, N. Y.; Secretary, O. G. Mason, Bellevue Hospital.

6. *Remarks on the Structure of Precious Opal.*—Prof. LEIDY has an article in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1876, p. 195, on the microscopic structure of the opal of Queretaro, Mexico.

7. *Shoal in the Atlantic* 300 *to* 400 *miles northeast of Madeira and* 130 *miles from Cape St. Vincent.*—Commander Gorringe, of the United States sloop Gettysburg, has discovered a bank in 36° 29′ N. and 11° 33′ W. with only thirty-two fathoms water over it, and 1525 fathoms to the southeast and southwest of it. It is about 200 miles west of the Josephine Bank which has a depth of eighty-two fathoms, and lies nearly in a line between Madeira and Cape St. Vincent. *Nature*, of March 1, gives a map of that portion of the Atlantic from Capt. Gorringe's soundings and those of the Challenger, in January, 1873, and the German frigate Gazelle, in 1874.

OBITUARY.

WOLFGANG SARTORIUS VON WALTERSHAUSEN, the distinguished author of works and memoirs on volcanic rocks, minerals, and phenomena, including extended treatises on those of Iceland and Etna, and Professor of Mineralogy and Geology in the University of Göttingen, died on the 16th of October last, at the age of nearly sixty-seven. He was the author also of memoirs on terrestrial magnetism, meteorology and paleontology.